# CONCEPTS OF AUTOMATION WITH IMPLICATIONS FOR PUBLIC EDUCATION

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A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF EDUCATION

UNIVERSITY OF FLORIDA
August, 1963

## ACKNOWLEDGEMENTS

To Dr. Aleyne Haines and Dr. Charles A. Cate, co-chairmen of the supervisory committee, the writer acknowledges his great debt: to Dr. Haines for her keen mind and slashing pencil; to Dr. Cate for his ability to go beyond the information; to both for their broad scholarship, patience, and understanding. Deep gratitude is extended also to other members of the supervisory committee, Dr. Maurice Ahrens, Dr. May Burton, Dr. Myron Cunningham, and Dr. Douglas Scates for their help and their support when it was needed most.

To his dear friend, Dr. Clara Olson of St. Leo College, the writer acknowledges a special debt. He hopes that the study is all she would want it to be.

A special thanks is due Mrs. Betty Jones of the audiovisual department whose cheerfulness helped always.

To his wife, Carol, the writer expresses his devotion and his gratitude for her patience and faith in him. To his children, Rebel and Tricia, and to all our children who face a complex tomorrow, the writer dedicates this study.

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# CHAPTER I

## AUTOMATION AND EDUCATION

In March, 1962, the Congress of the United States passed into law a bill providing $435 million for the training and retraining of a work force geared to the needs of automation.[1] In the same year, the federal government spent about $12 billion on scientific and technological research which ultimately would render obsolete thousands of jobs and job skills.[2] This is only one of the paradoxes of the early second half of the twentieth century with which Americans have been forced to live. There are others.

In recent years, 262,700 jobs have been lost in the soft coal industry while total productivity rose 96 per cent.[3] In the railroad industry 540,000 jobs disappeared; productivity increased 65 per cent.[4] Clearly, hundreds of thousands of jobs cannot drop out of sight while productivity leaps upward without concomitant imbalances occurring within the economic structure of the nation.

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[1] U. S. Congress, Manpower Requirements, Development and Utilization Act, Public Law 87-415, 87th Congress, S. 1991, March 15, 1962.

[2] Business Week, December 29, 1962, p. 42.

[3] Walter Buckingham, The Impending Educational Revolution, Occasional Paper Number 1 of the Educational Implications of Automation Committee (Washington: National Education Association, October, 1961), p. 2.

[4] Ibid.

This is only half the story, however, for technology is creating a demand for new skills almost as fast as it is displacing old ones. In many cases these new employment opportunities are not being taken. For example, the Autonetics Division of North American Aviation searched 125 colleges for 1500 persons of suitable education and training to fill positions created by new technology. They found 500 qualified students. The company turned away 137,000 applicants who could not meet educational and skill requirements.[1]

Admittedly, these jobs demanded a high degree of skill and technical proficiency. As experienced technicians move upward, however, vacancies are created in occupations requiring less skill. According to Seymour Wolfbein, director of the U. S. Bureau of Labor's Office of Automation and Manpower, the assumption underlying much of the federal government's entire retraining program is that hundreds of thousands of rather ordinary jobs (nurses aids, electronic helpers, machine tool operators, draftsmen) are unfilled at the present time because of the lack of trained people.[2]

Despite the hard fact that in the United States today economic opportunity is intimately bound up in the quantity and quality of formal education and training, almost one million youths between the ages of sixteen and seventeen are not enrolled in any school of any kind.[3]

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[1]Lester Velie, "Automation: Friend or Foe?" Reader's Digest, October, 1962, pp. 101-106.

[2]Miami Herald, March 18, 1962, p. 4-G.

[3]Buckingham, op. cit., p. 4.

Today's paradoxes are not solely confined to the realm of economics, however. The acquisition of ample leisure time has been one of man's goals. Yet, new technology, by increasing production with less work time, has raised the specter of an anti-intellectual leisure class afflicted with pathological boredom. Dr. Lan Frazer of the British Medical Association calls attention to the "diseases" of the twentieth century--the breakup of the home and the psychiatric and sociological problems of leisure--which are fast neutralizing the advances of medicine in our time.[1] Frazer states, "For them (the leisure-stricken) external resources are not sufficient--such as unlimited playgrounds, television, golf courses, museums.... You can always supply the toys but you cannot supply the play."[2]

George Friedman foresees the day when government itself may be forced to intervene in the leisure time pursuits of private citizens.[3] The thought of leisure by legislation underscores a trend of concern shared by some responsible people that the time spent off the job is of vital concern to the nation. The difficulties arising out of the increased leisure are further compounded by the efforts of organized labor. Stanley H. Ruttenberg, Director of Research for the AFL-CIO, speaking for the Union's fourteen million members, states that the primary weapon to be used against unemployment will be a national campaign for a still

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[1]Miami Herald, July 24, 1962, p. 2-C. [2]Ibid.

[3]George Friedman, The Anatomy of Work (New York: Free Press of Glencoe, Inc., 1961), p. 159.

shorter working week, hence more available leisure time.[1]

Even the anatomy of the land cannot escape the paradoxes created by technological change. The arterial systems of large cities, long clogged with the traffic of commerce, have burst, and the overflow is being pumped into the surrounding countryside. Dallas, Texas, is growing beyond imagination, but Lowell, Massachusetts, is dying.[2] Entire industries are on the move, and ordinary men and women are either swept along on the tide or left to perish in the economic backwash.

Thus, the technological phenomenon called "automation" descends upon twentieth century America. Alternately blessed and maligned, it moves through society like an elusive will-o'-the-wisp, raising hope here, working havoc there. Dr. Gordon Brown of the Massachusetts Institute of Technology says of automation, a "big thing--one of the biggest in history --whose horizons are still expanding as we learn more about its potentialities."[3] His colleague, Dr. Norbert Wiener, generally acknowledged as the "father of today's automation, does not completely share his enthusiasm. "It is my thesis," writes Wiener, "that machines can and do transcend some of the limitations of their designers, and that in doing so they may be both effective and dangerous."[4]

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[1]Stanley H. Ruttenberg, "Educational Implications of Automation as Seen by a Trade Union Official," Automation and the Challenge to Education, eds. Luther H. Evans and George E. Arnstein (Washington: National Education Association, 1962), p. 95.

[2]Velie, op. cit., p. 104.

[3]Quoted by Walter Buckingham in Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 5.

[4]Norbert Wiener, "Some Moral and Technical Consequences of Automation," Science, May 6, 1960, p. 1355.

## Technological Change: A Human Perspective

The social and economic upheaval accompanying technological innovation is not a phenomenon peculiar to our day alone. Its roots reach back into antiquity. Throughout the long course of man's relationship with technology, machines have continuously replaced some men's labor and upset other men's modes of living. In 1850, for example, machinery was installed in the silk mills of that section of London known as Spitalfields. The results were immediate and disastrous. The early morning streets rang with the weary tramping of displaced weavers as they searched and begged for work that had vanished. Then, as now, the cry of a desperate man often pierced the quiet dawn, "God, I've no work to do. Lord strike me dead--my wife, my kids want bread and I've no work to do."[1]

Men and work are no strangers, for men have bent their backs and poured their sweat onto desert sands and barren hills almost since time began. With their bare hands they tore civilization out of the sides of mountains. They scarred ancient landscapes with walls, roads, and ditches, clawed a handful at a time, from the unyielding earth. Men have always worked, and with a planet to tame, an abundance of work was always available.

From the beginning, however, men learned that certain tasks required strength and skill beyond his own physical capacities. To amplify

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[1] Samuel Gompers, Seventy Years of Life and Labor (New York: E. P. Dutton and Co., Inc., 1957), pp. 47-48.

his strength and extend the range of his effectiveness, man fabricated tools, crude extensions of himself. As he worked, he refined his tools, modified them, discarded them when they no longer satisfied him.

With the passing of centuries, man grew more adept at coping with his environment. The knowledge which he wrested through trial and error from the world about him bore fruit in a gradual sophistication of his mechanical devices.

He took pride in his tools, cared for them, decorated them with designs and symbols to set them apart from the tools of other men. Yet, he never really trusted them, for he was never quite sure if he owned them or they owned him. Deep within his stirring social consciousness he felt that these embryo machines were bending him, shaping him, creating an environment to which <u>he</u> had to adjust. As Mumford has intimated, man's machines seemed to have an existence apart from his own.[1] Eventually his fears were justified, for technology tamed him, timed him, then prescribed the boundaries within which he must live and die, and upon him built an industrial civilization.

True, in the long run, machines brought his progeny undreamed-of abundance. But individual man had died in the short run. His machines had built a world of capital investment, management and labor, a world fraught with problems for which his experience had not prepared him. There was iron to replace his muscle, but little to mend his pride or restore his humanity. With his children, he disappeared into dark

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[1]Lewis Mumford, <u>Technics and Civilization</u> (New York: Harcourt, Brace and Co., 1934), p. 322.

mines and gloomy factories, or trudged the grimy streets of mill towns, a victim of his own ingenuity, the first sacrifice to the great machines.

Now the wheel has turned full circle. New tools and new techniques have awakened old distrusts and inflamed ancient wounds. New platitudes somehow ring familiar: "Technology has accomplished more for civilization than all the other efforts of the human race."[1]

Because he is better informed, today's working man faces an acute dilemma, for he realizes that this nation must go forward or perish. Yet the road to advancement seems to wind through a forest of incredible machinery which he does not trust, clever machinery, waiting once more to use him then cast him aside.

Yet there can be no turning back, no standing still. Whether to perish by his own machines, or to drown in the economic tidal wave of international competition, that is the question facing man. What does the future hold for him? Where do flesh and blood human beings fit into "life automatic?" Have men been prepared to cope with the problems of living in an age of complex technology?

As of this writing, more than four million persons, willing to work, are without employment.[2] Labor-saving machinery and automatic control of production have begun to demand tribute from those who can least afford to pay, the young and the old. Young unskilled workers

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[1]Harold G. Bowen and Charles F. Kettering, A Short History of Technology (West Orange, New Jersey: Thomas Alva Edison Foundation, 1954), p. 102.

[2]U.S. Department of Labor, News Bulletin, USDL-5499, November 14, 1962, p. 2.

find it increasingly difficult to break into the labor market. Older workers see their jobs and their security drop out beneath them. The situation is not improving. In fact, it is steadily deteriorating, for automation is displacing between 25,000 and 35,000 workers every week.[1]

For a large proportion of the employed labor force, automation is creating an alien environment where skilled hands are still, and unpracticed minds must grapple with strange, new problems. Fingers and thumbs which once shaped the world find little joy in idleness. The challenge of making, of creating, has assumed an unfamiliar form, and when the machine is satisfied for a time, bewildered selves search for fulfillment beyond the walls of automatic factories.

Problems of terrible complexity arise which only new machines can solve. Yet new machines spawn other problems, equally complex, equally demanding, the least of which are technical in nature.[2] The technical and the mechanical may be locked within the factory, but the social problems spill over the walls and into the streets of suburbs.

As in the great industrial upheaval which overwhelmed our society at the beginning of the last century, the signs of a new revolution are in evidence everywhere. The age of the "thinking" machine is upon us, and it is within the realm of possibility that the

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[1] Luther H. Evans, Some Educational Implications of Automation, Occasional Paper Number 2 of the Educational Implications of Automation Committee (Washington: National Education Association, March, 1962), p. 3.

[2] R. H. Macmillan, Automation: Friend or Foe? (Cambridge: University Press, 1956), p. 88.

future of men may be determined by the flow of electrons off a cathode. Even now, every man, woman, and child in the United States is represented in the memory of at least one electronic digital computer as either a name, number, or statistic.[1]

## The Challenge for Education

The final report of the Twenty First American Assembly on Automation and Technological Change contains this brief but trenchant statement: "Education is both the root of technological change and the basis for successful adaptation.[2] The thought occurs that public education though tunefully singing a song of progress, is, and has been, in many instances, remiss in successfully adapting to, or perhaps better, assimilating the spirit of change to which it has given birth.

This does not mean, however, that public education in general had not made progress. On the contrary, in terms of increased enrollment and facilities, broader and richer programs of instruction, and the steady rise of professional preparation and competencies, there can be little real doubt concerning the progress of public education in the United States in this century.[3]

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[1]Stanley L. Englebardt, Computers (New York: Pyramid Publications, Inc., 1962), p. 7.

[2]John T. Dunlop, ed., Automation and Technological Change (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1962), p. 175.

[3]U.S. Department of Health, Education, and Welfare, Office of Education, Progress of Public Education in the United States of America (Washington: U.S. Government Printing Office, 1961).

Nevertheless, in spite of the progress, while industrial technology thunders ahead with all of its concomitant social and economic implications, public education often lags behind. Today's world is certainly different from the world of fifty years ago. Yet, one of the last nostalgic links with the past is the typical high school program which has not changed substantially in the last fifty years.[1] Seemingly unaware that its fortune and function are inexorably entwined in the on-going, dynamic conditions of life, public education bravely flags onward the future, while searching for security in the past. Industrial spokesmen succinctly state the case: "There seems to be a tendency for schools not only to fail to recognize change but to be reluctant to participate in it."[2]

Although automation is yet in its infancy, it has posed questions which ordinary men and women are not prepared to answer, questions which experts cannot answer; technical, social, and moral questions. Yet these must be answered. There are new skills to be learned, and new roads to be traveled. Men need help.

The Committee for Economic Development presents this challenge to education:

> Employment opportunities for the illiterate and the semi-illiterate are dwindling. Occupations requiring major skills and long training are expanding. We expect the

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[1] John Ramseyer, "A Concept of Educational Leadership," Association for Supervision and Curriculum Development, Leadership for Improving Instruction (Washington: National Education Association, 1960), p. 37.

[2] Oscar N. Serbein, Educational Activities of Business (Menasha, Wisconsin: George Banta Co., Inc., 1961), p. 110.

> schools to provide the necessary groundwork both for the acquisition of skills and for adaption to changing requirements.[1]

Over seven million young workers without high school diplomas are expected to join the labor force within this decade.[2] Of these, over two million will not have completed grade school.[3] What will become of them?

That the tools and techniques of productive labor cannot, with impunity, be divorced from the totality of life is an obvious truism. It is not within the scope of this study to define this relationship, for it has already been explored.[4] If the concern of governmental agencies, industry, labor unions, and private individuals means anything at all, if the excessive numbers of unemployed and the predictions of upgrading in the ranks of labor are to be taken seriously, however, then automation is not an ordinary tool or technique. Its implications for society, it must follow, will surely mean change which will, at least, be out of the ordinary. Social change in any form has usually been unsettling. What may we expect from automation?

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[1]Research and Policy Committee of the Committee for Economic Development, Paying for Better Schools (New York: Committee for Economic Development, 1960), p. 11.

[2]U.S. Department of Labor, Manpower, Challenge of the 1960's (Washington: U.S. Government Printing Office, 1960), p. 16.

[3]Ibid.

[4]For example, see William O. Stanley, Education and Social Integration (New York: Bureau of Publications, Teachers College, Columbia University, 1953), pp. 85-117.

Automation is today presenting public education with a formidable challenge, perhaps the challenge of the century. If education is to face up to its responsibilities it must strike boldly into the future, prepared to assist in the assimilation of innovation, prepared to use and instigate, if necessary, innovation toward the accomplishment of its own ends.

## Concepts of Automation

Thus far in this introductory chapter, the term, "automation" has not been defined, but has been used loosely to denote any technological process which seems to be upsetting the older ways of doing things. The reader will find this to be the case in much of the literature dealing with automation, for strange as it seems, while most responsible organizations, institutions, and individuals do agree that automation is posing problems that should, and must, be solved, there is little or no agreement on what automation is. There have been many attempts to define automation, and these have ranged from the rigorous concepts of industrial engineering to the rather vague notions of ordinary citizens.

In 1962, for example, at least three major efforts were made to define and delimit automation in some way. The first of these attempts was undertaken by the Educational Implications of Automation Committee of the National Education Association. At Washington, D. C., in January, 1962, representatives of industry, labor, education, political science, government, sociology, and other related areas were presented the task of deriving educational implications of automation.

This symposium was held under the joint sponsorship of the National Education Association and the International Business Machines Corporation.

The National Education Association team defined automation for the symposium rather rigorously, in terms of industrial engineering, as the feeding of machines without human intervention, and the application of "feedback" to the industrial process.[1] The symposium was further structured to discuss an hypothesis proposed by the Educational Implications of Automation staff concerning the "capture" of work time for educational activities.

In the discussion and papers which followed, the symposium seldom again referred to automation in terms of the definition, but instead, confined itself to discussing the implications of technological change.

The second attempt was sponsored by the American Assembly at Columbia University in May, 1962. Again, a noted gathering of experts from the various fields of industrial and intellectual enterprise met to discuss automation. A formal definition of automation (adapted from a British industrial and scientific report[2]) was offered, and then set aside. Instead, technological change became the focus of attention.[3]

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[1] Evans and Arnstein, op. cit., p. 11.

[2] Great Britain, Department of Scientific and Industrial Research, Automation (London: Her Majesty's Stationery Office, 1956).

[3] Dunlop, op. cit., pp. 1-2.

The third attempt was made at the level of the federal government on March 15, 1962, when the U.S. Congress passed the Manpower Requirements Development, and Utilization Act.[1] In November, 1961, at Los Angeles, the present Secretary of Labor, Willard Wirtz, addressed the Governor's Conference on Automation. Mr. Wirtz defined automation in, as he said "its corrupted but convenient sense: as covering all new devices which do what men did before." The definition would include the invention of the wheel, as Mr. Wirtz pointed out.[2]

On the basis of this approach to automation, $435 million of federal funds, over a three-year period, was allocated to the training and retraining of workers whose jobs had been lost to automation.

These three reports represent a current point of view shared by many responsible people in America today that automation is not really new. It is the latest and most advanced step in a continuing technological evolution which may be traced back through the Industrial Revolution to the invention of the wheel, and perhaps back to the crude tools and weapons of primitive man. As such, automation and technological change may roughly be equated. Since Western Civilization has lived so long with technological change, men have had previous experience in dealing with it. Technological change, in the past, has usually meant, at worst, short run displacements of labor and capital, and at best, long run improvements in living and working conditions. There is no

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[1]U.S. Congress, op. cit.

[2]Address by W. Willard Wirtz at the Governor's Conference on Automation, Los Angeles, November 27, 1961 (Washington: U.S. Department of Labor, USDL-IXLA-216, 1961), p. 2.

reason, at the present time, to suppose that technological advances will not follow the same pattern, and after a short, if untidy, beginning, eventually lead the way to a better life for all.

There is an opposing point of view, however, which might hold that none of the foregoing definitions actually came to grips with automation. This point of view would readily admit that technological change is a part of automation, but that technological change, as such, is not automation. Today's machines and industrial techniques are merely symptomatic of a deep-seated, fundamental movement in society not yet completely understood or identified.

Perhaps the foremost protagonist of this point of view is Norbert Wiener whose work in cybernetics made possible much of the technological innovation which others call automation. Dr. Wiener claims that man has had little or no experience in the past in dealing with complex servomechanisms such as are in use today and are on the drawing boards for tomorrow. Human beings have never before turned over so many judgmatical functions to machines whose rapidity of decision making renders man's efforts slow and clumsy in comparison. What is the proper use of such machines? Although most people would agree that man must remain in control of his machines, is effective control possible considering for one example, the incredible speed at which these machines operate? Dr. Wiener writes, "Machines may be subject to human criticism, but since machines are so fast, this criticism may be ineffective until long after it is relevant.[1] From Wiener's point of view, man has never been

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[1]Norbert Wiener, op. cit., p. 1355.

faced with this sort of technological challenge. He advises men to examine where their new ways are leading them.[1]

Proffering a similar point of view is Dr. Donald Michael whose report on automation to the Center for the Study of Democratic Institutions has been widely read and discussed. There is little doubt as to where Michael stands:

> There is a very good possibility that automation is so different in degree as to be a profound difference in kind, and that it will pose unique problems for society, challenging our basic values and the ways in which we express and enforce them.[2]

A great deal of the confusion and loose thinking surrounding automation stems from a lack of agreement on the essence and origin of automation. Nor is the disagreement as clear-cut and decisive as the foregoing presentation would seem to indicate, for there are many shades of agreement and disagreement. For example, management often regards automation as a process of upgrading labor.[3] Trade unions, on the other hand, see it more as a technique for replacing labor.[4] Both, however, would agree (as would others) that the end of this trend called "automation" is certainly beyond imagination at present, and that change is of the essence of automation, regardless of point of view.

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[1] Ibid., p. 1358.

[2] Donald N. Michael, Cybernation: The Silent Conquest (Santa Barbara: Center for the Study of Democratic Institutions, 1962), p. 11.

[3] Frank H. Cassell, "Educational Implications of Automation as Seen by a Business Executive," Evans and Arnstein, op. cit., p. 78.

[4] Ruttenberg, op. cit., p. 88.

Any study of automation, then irrespective of sponsorship or intent, must surely take note that differences of opinion as to what is and what is not automation do exist. To ignore this demonstrable fact would not seem fruitful. If public education is to meet the challenge of automation, the question arises, which automation? Each concept of automation carries with it a concomitant ensemble of implications for ultimate implementation in the field. Therefore, in the light of what has been said of automation two immediate problems face education at the present time:

1. Public education must find a concept of automation broad enough to have meaning for the profession, yet specific enough to suggest avenues of action.

2. Public education must then delineate and circumscribe that area of the automation problem for which it is responsible by law or tradition, and derive major implications of this for the education profession.

These two crucial problems confronting public education today will be of central concern in this study.

## Purpose and Method of the Study

The central purpose of this study is to arrive at a concept of automation that will be comprehensive enough to assist educators in becoming sensitized to social and educational problems related to technological developments and in interpreting and delineating those characteristics of the automation movement which are of major concern to public education.

The study will include several aspects of investigation: (a) the relationship which has emerged between men and machines in our culture will be explored in order to lend historical perspective to the study; (b) the assumptions underlying current concepts of automation will be examined with the purpose in mind of formulating or otherwise identifying a concept of automation broad and comprehensive enough to assist educators to interpret and delineate those characteristics of major educational concern; (c) major implications of this concept of automation for public education will be projected.

Since automation is generally viewed within an industrial context, much of the material used in this study will be derived from industrial sources. The study itself, however, will not be limited solely to industrial automation. Part of the task of formulating a broad and comprehensive concept of automation implies a perspective beyond the usual, but narrow, industrial setting. For this reason, industry will serve as a base for a more diverse type of exploratory analysis of automation as it occurs in other contexts.

The study will be focused upon those aspects of automation which appear to have major implications for public education.

The writer will review the literature of government agencies, including the U.S. Department of Labor's Office of Automation and Manpower; educational sources, including the Educational Implications of Automation Committee of the National Education Association; the writings, interviews, speeches, and reports of scientists, sociologists, industrialists, industrial psychologists, representatives of organized labor, educators, historians, and others who have addressed themselves to auto-

mation and the problems of technological and social change.

The major criteria for the selection of material will be the relevance of the material itself to the various interpretations of automation under discussion. That is to say, the value and appropriateness of the information investigated will determine its relevance. The credibility and scholarship of the authority, and the quality of the evidence offered in support of the data will also be considered.

Additional criteria for use in formulating major implications of automation for public education will be derived from a review of authoritative statements of purposes of education in professional literature.

## Basic Assumptions

It should be stated at the outset that this study is undertaken within a philosophical framework which accepts the worthiness of men, and which entertains an abiding faith in the ability of men consciously and intelligently to control their destiny. It is assumed, therefore, that present industrial technology, as the product of human intelligence, has purpose and direction, and that systematic investigation may clarify this purpose and direction.

It is further assumed that public education in the United States has a responsibility to the people in helping to identify the major problems inherent in automation, and in proffering solutions to those problems which lie within its area of responsibility.

It is assumed, also, that the goals of public education are formulated in the direction of the preparation of citizens for personal

and social growth, and for active and productive participation in a unique, democratic community.

## CHAPTER II

# MEN AND MACHINES IN WESTERN CIVILIZATION

Machines have brought us to the edge of space. Undoubtedly they will one day carry other men to the stars, but for a price. Machines complicate our environment. Technology, the science of machinery, brings change that disturbs existing patterns of thought, creates pockets of economic depression, and introduces novelty which is not assimilated evenly into the institutions, the value systems, and the day-to-day experiences of people. The resulting imbalance of these fundamental underpinnings is often both cause and effect of confusion and conflict within the societal complex.[1]

Other people at other times have faced similar problems of technological assimilation. The clash of the old and the new has ever been a part of dynamic cultures. In the accommodation and utilization of change, however, is the spirit of a nation tested. Its survival as a nation depends on its ability to regain equilibrium even at the cost of an agonizing reappraisal of traditional values and ways of doing things. A willingness to change is sometimes not enough, for unless the means

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[1]For a more thorough analysis of this theme, see William O. Stanley, Education and Social Integration (New York: Bureau of Publications, Teachers College, Columbia University, 1953), pp. 85-117.

of change are available, unless its institutions have incorporated a certain elasticity of function, a nation may be a witness to its own degeneration, yet powerless to do much about it.

The agencies of change within a given society are numerous, as are its institutions. Both are thoroughly intermingled in the whole society. To single out for treatment one quality of change, technological, and one kind of institution, public education, appears to be, and indeed is, a brash oversimplication of the relationship of events. For the sake of clarity, however, such procedure is often useful. Thus the focus of this chapter will be on the kind of change brought about by technological innovation during the course of Western civilization, and where relevant, on the action of one institution, public education, to prepare for, contain, or otherwise assist in the assimilation of such change.

The purpose of the chapter is to give a sense of history, a perspective, within which to view the dynamics of man's historical relationship with machinery. Santayana has said, "A nation that does not know history is fated to repeat it."[1] Perhaps. Nothing is lost by viewing the broad sweep of technological events that preceded our own day. If in the triumph and tragedy of other peoples we find a kinship in the pertinacity of the human spirit, much may be gained.

## An Historical Perspective

Since it has been said with some authority that Western culture

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[1]Quoted by Edith Hamilton, "The Lessons of the Past," Adventures of the Mind, eds., Richard Thruelsen and John Kobler, First Series (New York: Alfred A. Knopf, 1959), p. 79.

or at least European civilization, began in all seriousness with the Greeks and the Romans,[1] this period of time will mark the farthest boundary of this overview. It would perhaps be redundant to remind the reader that more ancient people utilized machinery with remarkable skill and success. The point at which the writer has chosen to step into the technological stream of history is purely an arbitrary one, selected because it seems to mark the beginning of our own civilization.

The Myth of Greece.--From east to west, Greek ideas shaped the arts and commerce of their time and of ours. They introduced the camel into Egypt and democracy into Europe. They gave us the cog wheel and the water wheel. With iron weapons, wooden levers, and leather bellows, primitive tools even for this time, the Greeks forged the base of commerce and carried it to the world.[2] They made of music a national institution,[3] and gave the world the mixed blessing of credit buying in the market place.[4]

With it all, Greece remained a "poor little country,"[5] a geographical term,[6] never quite a nation. The classic rivalry of Athens and

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[1]Hendrik Willem van Loon, The Story of Mankind (New York: Pocket Books, Inc., 1954), p. 52.

[2]Rene Sedillot, The History of the World in Two Hundred and Forty Pages, trans. Gerald Hopkins (New York: New American Library, 1951), pp. 43-61.

[3]Paul Henry Lang, Music in Western Civilization (New York: W. W. Norton and Co., Inc., 1941), pp. 12-16.

[4]Sedillot, op. cit., p. 61.

[5]Hamilton, op. cit., p. 73.

[6]Sedillot, op. cit., p. 43.

Sparta exemplifies the looseness, even the absence, of federation among the Greek states. Unity of purpose and community of common understandings were seldom, if ever, achieved.

When the world was slave, Athens was free.[1] Yet slaves outnumbered freemen four to one.[2] One person in ten was deemed worthy of educating.[3] Slaves and foreigners, the most numerous segment of the population, were denied education and participation in government. Ironically, trade and banking were in their hands.[4] It is startling but true that slaves and foreigners, not Athenian citizens, built and adorned the magnificent public buildings of Athens.[5]

The Greeks, eminently capable of technological advances (witness the genius of Archimedes and Hero), found it unprofitable to progress because of the abundance of slave labor.[6] Even Plato's ideal Republic was rooted in slavery. Free men cannot compete with slaves, human or mechanical, and Greece was no exception. The wages of the common working man, never much, were gradually forced lower. Ultimately he was squeezed out of competition.[7]

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[1]Hamilton, op. cit., p. 73.

[2]Sebastian de Grazia, Of Time, Work, and Leisure (New York: Twentieth Century Fund, 1962), p. 35.

[3]Harry Gehman Good, History of Western Education (2d ed., New York: MacMillan Co., 1960), p. 39.

[4]H. Michell, Economics of Ancient Greece (Cambridge: W. Heffer and Sons, Ltd., 1957), p. 144.

[5]Ibid., p. 145. [6]Ibid., p. 187.

[7]Sedillot, op. cit., p. 57.

Edith Hamilton, noted authority on Greek civilization, states, "The very best Greek minds, the thinkers who discovered freedom and the solar system, had never an idea that slavery was evil."[1] With few notable exceptions, Greek gentlemen despised the mechanical arts.[2] Instead, they directed their efforts toward government. Our word "idiot" comes from the Greek idiotes, meaning a "private" citizen, as against a "public" citizen.[3] A private citizen did not give his life to public affairs, and consequently endangered himself and his nation. The ideal was the public citizen, the man who dedicated himself to political theory, and left the running of mundane commerce to inferiors.

Michell has said, "In the last analysis no people, however gifted, can rise superior to its political and economic institutions."[4] The Greeks, the most enlightened and gifted people of their time, chose to separate the tools and techniques of productive labor from the totality of life. They failed to note that education is lived, not merely discussed or confined to the academy. They kept their gods on a mountain top and their slaves on the treadmill. It never occurred to them that better use could have been made of both. They toyed with education, never used it. Thus, history buried them even as they watched.

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[1] Hamilton, op. cit., p. 74.

[2] S. E. Frost, Jr., Essentials of History of Education (New York: Barron's Educational Series, Inc., 1947), p. 28.

[3] Hamilton, op. cit., p. 76.

[4] Michell, op. cit., p. 37.

Rome, Technician of Antiquity.--Under Rome, architecture and civil engineering reached heights not attained in any previous civilization.[1] To speak of the Romans as masters of brickwork would surely be redundant, for eloquent testimonial may be seen, even today, in the remains of their roads, aqueducts, and harbor jetties. As social engineers, however, Romans were tragic failures. They never developed the social and scientific curiosity necessary for the assimilation of technology into the total society. As they invented technology, so they used it with scarcely a plan or long-range purpose for its development. Its effect on the structure of their society was ignored. In the face of massive but haphazard technological innovation, it is not surprising then to find in Rome some of the first historic instances of technological unemployment.

The free Roman working man might find employment in the factories, the mines, or on the docks if he asked no more than the daily cost of a slave.[2] The Emperor Vespasian, hoping to stem rising unemployment, laid a ban on the use of mechanical devices to hoist columns into place on the Capitol.[3] This incident occurred during the two centuries which H. G. Wells has described as the apex of Roman greatness.[4] Seemingly unaware

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[1]Harold G. Bowen and Charles F. Kettering, A Short History of Technology (West Orange, New Jersey: Thomas Alva Edison Foundation, Inc., 1954), p. 21.

[2]Tenney Frank, An Economic History of Rome (Baltimore: Johns Hopkins Press, 1927), p. 337.

[3]Sedillot, op. cit., p. 79.

[4]H. G. Wells, The Outline of History, Vol. 1 (New York: Doubleday and Co., Inc., 1956), pp. 388-399.

of the source of their problems, Romans lived from day to day, and to the end, failed to muster an intelligent attempt to determine the role of technology in their society.

Wells writes that "the clue to all its (Rome's) failure lies in the absence of any free mental activity and any organization for the increase, development, and application of knowledge."[1] Strangely enough, imperial Rome was education conscious, after a fashion. Education was available to most Romans who could afford it; northern Italy boasted some public schools.[2] There can be little doubt that some formal organizations for the increase, development, and application of knowledge were present. As late as the Seventh Century, however, public education in Rome was still conducted in the Greek language, and herein, perhaps, lies a better clue to the failure of Rome.[3] Roman education did not reach the masses; Roman education took scant notice of life conditions but concerned itself with the rhetoric and grammar of a bygone age. Roman education was an adjunct to life, an amusing pastime to be taken or left as the mood occasioned. Its relationship to daily existence was never discovered.

In the final hours, the mighty Roman legions that once had conquered the world on a fare of wheat porridge, preferred their leisure and self-inflicted wounds to the defense of Rome's walls.[4] Wave after wave of Vandals, Ostrogoths, and Huns swept over Western civilization while the

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[1] Ibid., p. 397.

[2] Good, op. cit., p. 53.

[3] Sedillot, op. cit., p. 80.

[4] Frank, op. cit., p. 339.

Rome of the god-Caesars crumbled. Freemen and slaves were slaughtered in the streets. Although Romans outnumbered barbarians, none rose to her defence.[1] It was the end.

Technology in the Middle Ages.--Like the phoenix of Egyptian fable, European civilization rose slowly from the ashes of Rome. At the very heart of swirling clouds of magic and mysticism, tiny, embryonic sciences fought desperately to live. Little things marked their beginning. In England, the horse collar transformed the horse into a more efficient machine. The hand crank multiplied raw muscle power. In the market place appeared cast iron tools and utensils.[2]

Perhaps the most far-reaching technological development, however, occurred not in the infant industries of Europe but in the monasteries. There, apart from the world and secure in their disciplined way of life, certain men divided their days into labor and prayer.

The most influential of these monastic societies were the Benedictines. They more than any other were responsible for the rigid structuring of the day. Rule XLVIII of the Order of St. Benedict states: "And therefore, at fixed times, the brothers ought to be occupied in manual labor, and, again at fixed times, in sacred reading."[3]

But time was not so easily fixed, for until then, time, the somber pavan of the measured moment, was unknown to men. Undaunted, the brothers

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[1]Wells, op. cit., p. 395.

[2]Bowen and Kettering, op. cit., pp. 37-38.

[3]Quoted by de Grazia, op. cit., p. 41.

erected bell towers which ultimately tolled away the age of man, and ushered in the age of machines. The word "clock" comes originally from the Celtic, clocca, bell tower.[1] Today we wear on our wrists a smaller version, the watch, whose meaning is obvious and intended.

Thus, the monasteries perfected the clock, an ingenious machine which has altered the ways of men perhaps for all time. Willingly men bound themselves to the mechanical dimension which they had invented, and circumscribed their days and their lives by minutes and hours. They bought a measure of precision, but the price was dear. They paid for it with their freedom.[2] Only the poet saw the clock for what it was:

> Noble machine with toothed wheels
> Lacerates the day and divides it in hours...
> Speeds on the course of the fleeing century.
> And to make it open up,
> Knocks every hour at the tomb.[3]

Soon the weight of minutes and hours wore heavily on man's spirits. Time saving became time serving. Already it was too late to retreat, for a new mode of living had been built upon the clock. Ordinary men bent their backs until the clock freed them. Curious imaginations discovered a world of gears, levers, and springs. Because of the clock, there slowly materialized a climate capable of supporting the complex machines of the future.[4]

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[1] Ibid., p. 304.

[2] Lewis Mumford, Technics and Civilization (New York: Harcourt, Brace and Co., 1934), p. 14.

[3] Ciro de Pers, Seventeenth Century, Quoted by de Grazia, op. cit., p. 311.

[4] Mumford, op. cit., p. 59.

Public education at this time was practically nonexistent, and what did exist was vested in religious authorities who were not yet ready to accept life as much more than an annoying prelude to eternity. Tragically, this meant little education for anyone.[1]

Church schools were founded in some places but certainly not to point the way to technical literacy. Monks and priests charged with educating the fortunate few were themselves poorly educated. Even the enlightened Charlemagne made scant literary headway.[2] What chance then had lesser men?

Incredible poverty, disease, and filth were accepted by men as the normal circumstances of everyday life. Men lived and died in hardship and ignorance, sustained by the promise of a better life beyond an early grave. The house chimney was a luxury; the tallow candle a miracle.[3]

Thus, one thousand years after the birth of Christ, approximately three thousand years after the beginnings of our own civilization, the role of technology in human affairs had not been explored. The Greeks had ignored technology as a science of mechanical work, and instead, had concentrated on a disembodied aestheticism which they mistook for education. The Romans, on the other hand, enshrined technology, but failed to develop an education broad enough to explore it as a social phenomenon. With the advent of Christianity, the science of machinery inched forward acquiring

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[1]T. L. Jarman, Landmarks in the History of Education (New York: Philosophical Library, 1952), p. 78.

[2]Ibid., p. 58.

[3]Adapted from Sedillot, op. cit., pp. 124-125.

a slow but steady accretion of inventions and mechanical concepts. Education as a public institution, however, was practically nonexistent. As technology grew away from its societal roots, the beginning of a gap in the relationship between men and machines was created. We have yet to close it.

The Dark Ages of the Machine.--After one thousand years of Christianity, the course of European civilization began to come into focus. Clearly, the trend was toward increased mechanization with less reliance upon human capacities in the performance of work. The next eight centuries witnessed a consolidation of the infant sciences and industrial processes which ultimately, in the Industrial Revolution, confirmed the direction of social and economic change, and which in our own time have thrust us, breathless, into the complexities of automation.

These eight centuries encompassed also a revolution of the arts. Scholars sifted the dusty relics of antiquity to rediscover lost arts and graces. This classic treasure hunt culminated in the Renaissance of the middle centuries, and brought about a re-evaluation of human creativity not resolved to this day.[1]

England became the clearing house for inventions from all over the world.[2] The telescope, cheap paper, print, the printing press, the magnetic compass--these and other innovations were absorbed into British

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[1]Milo Wold and Edmund Cykler, An Introduction to Music and Art in the Western World (Dubuque, Iowa: Wm. C. Brown Co., 1955), pp. 102-129.

[2]Mumford, op. cit., p. 112.

commerce. That technology had arrived in England was evident. Not so evident was the fact that this technology would grow geometrically. A gear system designed for a certain application, for instance, could often be adapted, with some modification, to other systems. This in turn led to further adaptations and modifications. Infant technology mushroomed beyond expectation.

The most important invention of the period, however, involved not a product, but a process: the scientific method.[1] Emerging order and precision, accuracy in observation and application replaced chance and blind trial and error. The final barrier to advanced technology had been swept aside.

Toward the end of this period other revolutions were in the making. The trend to industrialize seemed to have outstripped the need to humanize. Now and then a lone voice, centuries ahead of itself, cried out in behalf of the masses who were being swept along on a tide of gears and belts, to the brink of social disaster. The Czech educator, Comenius, called for a popular education based on the needs of people, the need to understand and use, and not to be abused by, the encroaching forces of industrialization.[2]

Rousseau, looking back on the education of the time, cried, "...words, words, words."[3]

Too late. Technology already ahead of its social rationalization,

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[1] Ibid., p. 131.

[2] Jarman, op. cit., p. 196. [3] Ibid., p. 203.

engulfed the slow timetable of reform. How could it be otherwise when one inventive mind could render obsolete the philosophical and social foundations of generations? Such a mind was Leonardo da Vinci's. He invented a flying maching, alarm clock, wheel barrow, ship's log, steam cannon, submarine, anti-friction roller bearings, universal joint, beval and spiral gears, and so on until most fields of human enterprise were in some way touched by his genius.[1]

Western civilization, already thriving in a climate of growing industrialization, accepted and utilized these and other inventions. By the end of this period, in fact, most of the key inventions had been made.[2] A massive foundation of technology and scientific methodology capable of supporting a technological break-through had been built. Unquestionably, the stage was set and the players were in the wings for the "upthrust into barbarism."[3] that men have called the Industrial Revolution.

<u>The Industrial Revolution</u>.--The rattling and clanking of primeval machinery announced the dawning of a new age, the time of the machine. Enthroned within gloomy, airless factories, monster machines, spewing lint and dust and saturating the air with strange smells, screamed for attention. Hordes of men, women, and children fed them, bathed them, and carted away their waste. Thus began the age of quantification.

New sources of power and new materials, subtly at first, but soon

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[1]Mumford, <u>op. cit</u>., pp. 139-140.

[2]<u>Ibid</u>., p. 59.

[3]<u>Ibid</u>., p. 154.

with brazen indifference, hammered out new social objectives. How many? How big? Life values were brushed aside. Power, not for the fulfillment of human needs, but for its own sake, distorted and twisted human judgments. As the machines ground out goods beyond the wildest dreams of men, fortunes were amassed. The welfare of ordinary people was forgotten.[1]

Technology, having rendered slavery unprofitable, turned now with a vengence on manual labor. A man of skin and bone could not compete with a thing of iron. Wages were driven into the ground; entire families indentured themselves for life to the machine.[2] There followed then a period of human misery and degradation seldom equaled in any society.

Down, down into mines swarmed colonies of human beings. They buried themselves alive for pennies a day. For these unfortunates there was no release and little hope. Vainly they sought escape. In London men buried their hopes in gin. The signs in the saloon windows read: "Drunk for a penny, dead drunk for twopence."[3]

Blunt iron ships plowed the routes of ocean commerce. Across rivers polluted with industrial wastes iron spans and girders arched against the smoke-blackened sky. In teeming cities skyscrapers ominously towered over the people.[4]

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[1]Adapted from Mumford, op. cit., p. 151.

[2]Ibid., p. 154.

[3]Charles Singer et al., eds., A History of Technology (Oxford: Clarendon Press, 1957), Vol. III, p. 11.

[4]Mumford, op. cit., pp. 205-210.

Tools to cut and shape the materials of industry were perfected. Men were pitted against the drill, the planer, and the lathe. Men lost, for the machines worked better and faster. Even the speed of vehicles increased beyond belief.

The steam engine has been called the greatest invention of all time.[1] It ran on the tears of strong men and the pitiful sweat of four-year-old-children.[2] It lowered the standard of living so much that as late as 1810 over two hundred offenses in England called for the death penalty. Often starving children were hung for the theft of food.[3]

Though it is not the purpose of this chapter to speculate concerning the incredibly inhuman conditions of this time, it should be remembered that our present day concern with the welfare of the individual human being is of relatively recent origin. Motherhood itself has undergone some fundamental changes since the Industrial Revolution, for as de Grazia reminds us, the capitalist did not tear children from their mothers' laps; mothers sent their children to him.[4]

Technology was, and to this very day is, often regarded as impersonal. The men who invent seldom understand the full ramifications of their inventions. The "Edison effect" which gave us radio and all that

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[1] Ibid., p. 153.

[2] Heinz Gartman, Rings Around the World, trans. Alan C. Readett (New York: William Morrow and Co., 1959), p. 21.

[3] Geoffrey Grigson and Charles Harvard Gibbs-Smith, eds., Things (New York: Hawthorne Books, Inc., 1957), p. 180.

[4] de Grazia, op. cit., p. 199.

followed is a fair example of the shortsightedness of inventors.[1] The ultimate end, the social, economic, and philosophical implications of new technology has usually been thought of as beyond the vision of the inventor, certainly beyond the operating scope of the entrepreneur. Only recently, since the advent of mass destruction, mass invention, and mass unemployment has this position been seriously challenged. At the turn of the nineteenth century, however, technology disclaimed responsibility for the plight of the working man. The god of the machine plotted the destiny of people.

In England where the Industrial Revolution gathered its forces for its thrust upon the Western world, public education appeared to be divorced from the main stream of human events. In a nation rife with social injustice and on the brink of technological upheaval, a classical curriculum based on Latin and Greek championed values held by people at other times. Ancient languages, not the cold hard facts of reality were the focus of educators' efforts.[2] Outside the school walls common people lived in poverty and died in misery. Within the halls of learning, scholars lauded the virtues and values of Ancient Greece (as we have seen, also a victim of her own lack of foresight), and listened to the songs of Homer, oblivious to the cries of men's children in the streets.

Reform came when mobs of students ranged the corridors and rooms

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[1]Monroe Upton, Electronics for Everyone (New York: New American Library, 1954), p. 127.

[2]Jarman, op. cit., p. 230.

of venerable institutions, destroying, angry, not knowing what to do but certain that all was not right and something had to be done. At Winchester and Rugby soldiers with fixed bayonets were called upon to put down student riots.[1] General reform brought more people into schools, and schools into more intimate contact with people. Through the addition of modern history, mathematics, and modern languages to the curriculum, education at last was forced to take a more active part in on-going events.[2]

The young United States, soon to import the Revolution, had a history of education going back to 1642.[3] Though the idea was sound, the implementation was based more on religion than on reality. Handicapped by the lack of fundamental understanding of the educative process and burdened with a curriculum top-heavy in religion and religious reading, American education did little to prepare the people for the coming of the machines.[4] Tragedy was averted because of a bountiful land awaiting exploitation and not in any significant part because of American schools.[5] Colonial education which offered opportunity only to the children of the wealthy, and a sometime education in charitable and religious institutions to the offspring of the poor,[6] afforded scant protection against the

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[1] Ibid., p. 232.

[2] Ibid., p. 235.

[3] Good, op cit., p. 373.

[4] Ibid., p. 376.

[5] Roger Burlingame, Machines That Built America (New York: Harcourt, Brace and Co., 1953), pp. 13-14.

[6] U.S. Department of Health, Education, and Welfare, Office of Education, Education in the United States of America (Washington: U.S. Government Printing Office, 1960), p. 1.

technological storm sweeping across the Atlantic. In a land that cried out for the axe and the plow, serious education was suspect. "Damn your soul! Make tobacco!" the founders of William and Mary were told.[1]

Thus it was that the common man of these revolutionary times found himself virtually alone, facing an array of terrifying machinery. Blindly he struck out at the machines which seemed to rob him of his humanity and his bread. In England as early as 1768 angry workers completely demolished a saw mill.[2] There followed then such an orgy of machine breaking that in 1812 the British Parliament, stung by the wanton destruction of the Luddites, decreed the death penalty for vandalism.[3]

The significance of this period, the Dark Ages of the machine, lies not so much in what was accomplished technologically, but rather to what it led. Lewis Mumford suggests that the search for technological order and its relationship to humane living was born in the chaos of the Industrial Revolution.[4] Never again, except in modern warfare, has technology been permitted to deal so freely with the lives of men.

The Nineteenth Century: Aftermath.--Although technology ground steadily forward through the 19th Century, humane work was still beyond the horizon. Some improvements came to the workshop and the factory. A French law of

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[1]de Grazia, op. cit., p. 257.

[2]Bowen and Kettering, op. cit., p. 51.

[3]Gartman, op. cit., p. 9.

[4]Mumford, op. cit., pp. 210-211.

1841 forbade the hiring of children under eight years of age for factory work.[1] Unemployment, old age, accident compensation, working and living conditions were issues seldom dreamed of, even less discussed at this time.

It is said that King Charles II of Great Britain laughed uproariously when told that his royal scientists spent their time weighing air.[2] The 19th Century found the world of minute particles not so ridiculous. Some of the greatest minds of the time investigated the properties of submicroscopic matter. Their pioneering work led directly to our own sophisticated efforts in similar areas.

To follow closely the trail of technology through this century would be an undertaking of no small proportions, and neither practical nor desirable at this time. In general, big industry got off to a running start in America with the Civil War.[3] Conscious of the wealth of minerals, lumber, and other resources awaiting the venturesome, American business interests began the mass steam-rollering of natural beauty which, in the final stages, threatened to denudate our forests and pockmark our countryside.[4]

With the United States firmly established as an independent political entity, American educators shifted the focus of their efforts from the religious and the political to the needs of a growing industrial

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[1]Shepard Bancroft Clough, Economic History of Europe (3d.ed., Boston: D. C. Heath, 1952), p. 525.

[2]Mumford, op. cit., p. 25. [3]de Grazia, op. cit., pp. 263-264.

[4]Ibid., pp. 263-264.

nation. Education entered into a utilitarian phase, and under the leadership of such men as Horace Mann and Henry Barnard, free public schools became commonplace.[1]

The economic fortunes of common men improved more slowly. In 1891, Pope Leo XIII, in his encyclical Rerum Novarum, wrote: "It is neither just nor human so to grind men down with excessive labor as to stupefy their minds and wear out their bodies."[2] More than thirty years later, in 1929, the Conference on Unemployment counseled management that "...workers can be easily added and subtracted...machinery can be less easily adjusted."[3] People were expected to shift for themselves, and to work out their own solutions to problems over which they had no control and for which they had no answers.

Summary.--Approximately at the turn of the 19th Century technology burst into bloom in the Industrial Revolution of Western Europe. Supported by a solid foundation of mechanical and scientific principles, machinery began to supplant the worker. The working man was forced to acquiesce to the demands of a new work environment or starve. Often he did both. Human suffering of such proportions cannot long be ignored, however. Throughout the 19th Century, both in Western Europe and in America, workers feebly but resolutely challenged the morality of industry, and

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[1] Frost, op. cit., p. 173.

[2] Anne Fremantle, ed., The Papal Encyclicals in Their Historical Context (New York: New American Library, 1956), p. 185.

[3] Conference on Unemployment, Recent Economic Changes in the United States (New York: McGraw-Hill, Inc., 1929), Vol. I, pp. 177-178.

through political means sought redress of grievances. If they accomplished little, at least the machine had been challenged. That alone was an improvement. For the first time, people began to turn toward education as a means of understanding their environment. With the remaking of education in terms of popular needs, public education became a reality. At last an awareness of technology as a social phenomenon was dawning.

## Toward the New Revolution

With the beginning of the 20th Century, American industry began to grow away from its West European counterpart. New production techniques, new machinery, in fact a new philosophy of work combined to make the American industrial effort unique in the world's work. For this reason, a shift in focus of this discussion seems necessary. Although technology continued to exert tremendous influence on the development of other nations, East and West, the remainder of this discussion will be concerned primarily with technology as a force in the shaping of life in the United States.

Early in the present century men fulfilled an ancient dream: they soared into the sky in flimsy boxes of wood, wire, and canvas. On the ground appeared the Model T. A vast technology was built around these two inventions, the plane and the auto, a technology so complex and diversified that even today we can not see the end of it.

Thomas Edison, America's homespun da Vinci, put more men to work than any other human being.[1] To list his inventions and trace them through

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[1] Bowen and Kettering, op. cit., p. 17.

their adaptations and modifications would in iteself constitute a study of major proportions. Edison created not only things, but also a philosophy of living for millions of people all over the world.

Twentiety Century America crowned the consumer King. To meet the demand for goods, supply countered with radical methods of production. In 1908 the cost of a Model T was $950. By 1915, the Ford Motor Company was stamping, assembling, and selling 250,000 Model T's for $490.[1] Mass production had come of age.

Human assembly lines in conjunction with machinery developed the industrial techniques for which America became famous. Raw materials were inserted at the beginning of the line, underwent a series of fragmented operations by hundreds, often thousands, of workers, and a finished product emerged at the end.

The worker had grown accustomed to his role as master of the machine. At his command awesome machinery shaped, stamped, drilled, and conveyed heavy, bulky goods from station to station. Overlooked at the time were the implications of this sort of work for the total human organism. The factory hand had failed to notice that the machine, if master no longer, was at least equal, for it paced him, and he worked to its rhythm and capacity. No longer the servant of the machine, the worker became what perhaps is worse, a part of, an adjunct, to the machine. Henry Ford, surveying the vocational requirements of mass production said that the ideal factory worker would be a trained ape.[2]

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[1] Ibid., p. 93.

[2] R. H. Macmillan, Automation: Friend or Foe? (Cambridge: University Press, 1956), p. 55.

The first half of the 20th Century witnessed the clash of world arms. Systematic destruction on a scale unheard of in human affairs created demands which taxed to the limits the productive capacities of industrialized nations. American industry responded magnificently. It literally buried the foe under tons of material.

Spurred by the unnatural market of war (a false market, really, because it is based on waste and destruction and not on popular consumption), the American standard of living climbed steadily higher. Technology, already precocious, thrived and prospered in this climate of planned obsolescence. Suddenly, during the lull between World Wars, the danger signs flashed. Between 1919 and 1929, while production actually increased, two million workers in the United States lost their jobs.[1] Technology, almost unnoticed, was changing the concept of work. Better machinery and improving efficiency began to squeeze the worker. New concepts of assembly and production requiring less human intervention were slowly finding their way into the factory and machine shop. The old ways, including the old education,[2] could not exist side by side with the new technology. They were incompatible.

Emergency measures by governmental agencies in the United States, through a series of reconstructive and "make work" efforts sought to impose an artificial balance upon the nation's economic and social structure. World War II brought an end to this crisis, for the forces of

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[1]Mumford, op. cit., p. 228.

[2]See John Dewey, Democracy and Education (New York: Macmillan Co., 1916), p. 4.

destruction and waste were again on the rampage. A ready market for galloping technology solved the problem for the time being. The solution was in reality an evasion, however, for the technology which emerged from World War II catapulated us into an era undreamed of except in the pages of science fiction.

The New Technology.--We in our country and in all of the industrialized world have been enveloped in a wave of such incredibly advanced technology that authorities generally agree that the second Industrial Revolution is already underway.[1] A typical listing of jobs from the classified section of a large city newspaper includes these: systems engineer; guidance analysis engineer; electronic packager; telemetry designer; systems analyst; programmer; data processing instructor; microminiaturization specialist; rocket propulsion systems engineer.[2] The amazing fact is this: ten years ago most, if not all, of these jobs did not exist.

It is safe to say that machines have certainly extended the power of humans, and opened the worlds of the infinitesimally small and the incredibly large. Rome, luxuriant Rome at the height of her influence, is said to have had fewer slaves than present day Americans. One third of the Roman population owned three human slaves per capita. On an energy basis, the average American has 260 slaves to do his bidding.[3] Machines in the

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[1] Stanley H. Ruttenberg, "Implications of Automation as Seen by a Trade Union Official," Automation and the Challenge to Education, eds., Luther H. Evans and George E. Arnstein (Washington: National Education Association, 1962), p. 87.

[2] Miami Herald, July 7, 1963, p. 12-G.

[3] Bowen and Kettering, op. cit., p. 102.

home, the office, the factory, and the farm have made life more meaningful, certainly more abundant. Yet, how far have we come?

In the United States today, millions are unemployed; other millions live and work in the shadow of threatened unemployment. New technology threatens not only skills but entire classes of skills. Although the standard of living is climbing for some, for others it has dropped. In March, 1961, the editor of Fortune magazine estimated that thirty two million persons in the United States were living in poverty.[1] In a nation whose way of life has been offered as an example for the world, this is indeed a poor showing.

Even the employed cannot escape the consequences of new technology. Skilled machinists, for example, exert less physical effort than most other workers. Their job environment is clean, pleasant, and scientifically designed to provide optimum working conditions. They are well paid. They enjoy an abundance of leisure time, vacation time, and job security. But they have the highest incidence of gastric ulcers in the hourly paid working group.[2]

U.S. technology is on the threshold of space conquest. Mariner II, the incredibly complex instrument package which explored the environment of the planet Venus, is an example of sophisticated technology surpassed by few other nations.[3] To maintain control of a vehicle across

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[1] Seymour Melman, The Peace Race (New York: Ballantine Books, Inc., 1961), p. 90.

[2] Walter Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 94.

[3] Time, March 8, 1963, pp. 76-80.

thirty six million miles of space is surely a feat of daring ingenuity. Yet the traffic problems of large cities seem to be beyond control. In the Borough of Manhattan, for example, trucks average six miles per hour. Horse-drawn traffic of the '20's managed an incredible (by present standards) eleven miles per hour.[1]

How is it possible that a nation so dedicated to innovation has the only large, unused production and labor resources in the world?[2] (It has been suggested, seriously, that our blue and white collar workers be exported to other nations who need their services.[3]) How is it possible that a nation so technologically advanced cannot support so many of its own citizens?

To compound the difficulty and to add to the backlog of unsolved problems, some of which may be traced back to the Industrial Revolution, a new revolution is underway. This, despite the fact that the old revolution has yet to be assimilated completely. As a nation, even as a civilization, Americans have yet to learn how to use technology to its best advantage. Almost two thousand years ago, the Roman emperor, Vespasian, outlawed the winch.[4] During the early years of the Industrial Revolution, the Luddites attacked the problem of technological innovation

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[1]Seymour Melman, The Peace Race (New York: Ballantine Books, Inc., 1961), p. 92.

[2]Ibid., p. 65.

[3]Donald N. Michael, Cybernation: The Silent Conquest (Santa Barbara, California: Center for the Study of Democratic Institutions, 1962), p. 27.

[4]Rene Sedillot, op. cit., p. 79.

by destroying the machinery.[1] In the 19th Century France a bill was introduced into the Chamber of Deputies making it illegal to sharpen an axe.[2] Dull axes kept men busy. Nor have we moved much closer to a solution in modern America. "Useless" firemen still ride diesel locomotives, and some carpenter unions forbid the use of spray guns and power tools on the job.[3] Technology has grown more sophisticated through the centuries. Unfortunately, in too many instances, human judgment and perceptions seem not to have kept pace.

For better or worse, as Norbert Wiener notes, two essentially foreign agencies, men and machines, have been coupled together.[4] Where this union will lead is anyone's guess. Thus far, in the history of Western civilization, the evidence seems to support the view that industrial nations have failed to understand the nature of this relationship. A completely satisfactory rationale for the human use of machines has yet to be formulated.

In the past, after periods of confusion, conflict, and not a little tragedy, our nation somehow adjusted to technological change, and managed not only to keep going, but also to emerge from the crisis stronger and perhaps a little wiser. Whether this will continue to be the case is a moot question. An economy based on ever-expanding markets, dynamic

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[1]Heinz Gartman, op. cit., p. 9.

[2]L. Landon Goodman, Man and Automation (Baltimore, Maryland: Penquin Books, Inc., 1957), p. 272.

[3]Time, March 1, 1963, p. 15.

[4]Norbert Wiener, "Some Moral and Technical Consequences of Automation," Science, May 6, 1960, p. 1358.

competition, and a willingness to innovate, would seem to rule out the possibility of permanent, cyclical patterns. Yet this line of reasoning is often heard today. Reuben E. Slesinger writes, "... the lessons of history indicate that, somehow or other, and in due time, adjustments to these disturbing forces are made and ... the economy ends up stronger."[1] This is an assumption that needs exploration.

The Changing Role of Education.--Education in the United States arose out of a public need, a need to be informed; a need to be equipped, intellectually, to grapple with the environment. The wide public interest in education today has served notice that the needs of the public are changing, and education is expected to change with them. But change from what to what? Where are we going? While we may not know the answer to these questions, we do know that technology will create, has in fact created, new public needs which education must serve.

Unlike Greece, Rome, and medieval Europe, we know that technology and education cannot be practiced in isolation. We can no more walk away from work than we can walk away from life. We have learned that the education ends when life does. These are great lessons. They took four thousand years to learn. Yet lessons are only the ghosts of action. If we are to act intelligently, we must know with what we are confronted. In short, if public education is to meet the challenge of automation, there is a prior question to answer: what is automation?

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[1] Reuben E. Slesinger, "Automation: Its Implications for Today's Economy," Social Science, April, 1961, p. 109.

## CHAPTER III

## TECHNOLOGICAL CHANGE: EVOLUTION OR REVOLUTION?

Most writers and commentators on the industrial scene today generally agree that automation, whatever it means, means change. Interpreting the kind of change we are experiencing, however, is another matter. Briefly, it amounts to this: is the quality of change evolutionary or revolutionary? Does current change represent the latest step of an interrelated sequence of technological events dating back to, perhaps, the Industrial Revolution? Or does it imply a total radical departure from historical patterns of technology? This is simply another way of asking, can we depend on past experience with technological innovation to guide us through current crisis, and is it reasonable to expect the usual outcome; or must we learn to cope with new, revolutionary patterns of technology which imply new approaches and unexpected outcomes?

There are deep issues here for public education. If current technological change is of an evolutionary nature, then public education (and all public institutions) have a backlog of experience and methodology plus a substantial body of knowledge to bring to bear upon the problem of assimilating such change. Should the opposite prove true, should today's change indeed prove to be a revolution of technology, what part of past experience, methodology, and knowledge will have relevance

for this new concept? What additional experience, methodology, and knowledge will be needed in order to contain it? This, briefly, is the crux of the technological change problem as it faces public education today.

Within the context given above, current change cannot be at the same time both evolutionary and revolutionary. It is predominately one or the other. If it can be shown that it does indeed depart radically from historical patterns of technology, then today's technological change may reasonably be termed revolutionary. The purpose of this chapter is to present evidence on this point derived from an analysis of significant technological advances.

The manufacturing process as it has been carried on since the Industrial Revolution to the present day will be analyzed. The critical aspects of manufacturing will be pointed out. The purpose of this analysis will be to examine the quality of change that has affected critical aspects of manufacturing in the past and is acting on them today. Substantial evidence will be presented to illustrate the fact that the manufacturing process has undergone some recent changes which cannot logically be construed as part of an interrelated sequence of past events. This being the case, what is happening today must be understood in its present operational context.

An analysis of manufacturing has been chosen for two reasons. First, the manufacturing process, involving as it does the observable fabrication of a tangible product, lends itself well to the inspection of both process and product. Second, manufacturing both by size and influ-

ence is the most important of our production industries.[1] Even the service industries are involved in great part, with selling or otherwise merchandising the products of manufacturing. Consequently, any change in the traditional patterns of manufacturing will have repercussions throughout the entire industrial complex. If the changes coming to manufacturing are revolutionary, we would expect to find the revolution spilling over into other related and dependent areas.

It has been suggested previously that work and life are inseparable. The one is part of the other. To explore technological change apart from the social climate which is often both cause and effect of such change is to misrepresent reality. In this discussion technology and its social environs will be considered concomitantly except in those instances where such consideration would obscure meanings.

While the immediate purpose of this chapter is to examine whether the nature of today's technological change is evolutionary or revolutionary, the overriding aim of the analysis is to derive some guidelines for viewing additional aspects of automation which will have implications above and beyond industrial connotations.

## Power and Control of Power in Manufacturing

The manufacture of a product involves the meaningful application of two vital forces to a raw material, power and the control of power.

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[1]U.S. Department of Labor, Manpower: Challenge of the 1960's (Washington: U.S. Government Printing Office, 1960), p. 6.

Power is needed to do the bending, drilling, shaping, handling, and the many other operations requiring overt action. On the other hand, power is productively useless unless it is applied purposively toward a predetermined end. Power must be controlled. Although other peripheral services doubtlessly contribute toward the fabrication of the final product, it is in the application of these two forces, power and the control of power, that the product itself is born.

Until the Industrial Revolution man himself was the principal source of power and control. True, since earliest time, domesticated animals, wind, and water, harnessed to crude machinery, often relieved man of the more burdensome aspects of supplying power. In general, however, ancient man himself shaped the face of the ancient world with his own physical energy.

With the coming of the great machines, however, the locus of power began to shift from man to machine. Though the shift was gradual (not complete to this day), man as the principal source of power in the manufacture of goods became theoretically obsolescent.

<u>The Locus of Control</u>.--The Industrial Revolution was characterized, where practical, by the replacement of human mu^cle by power machinery. The control of machinery, however, with the exception of two historic anomalies, remained firmly in human hands. The two exceptions to the general technological trend are of more than passing interest, however, for they anticipated by more than a century and a half another revolution perhaps more profound than the first.

In 1788, James Watt, the gifted inventor of the steam engine,

designed a completely automatic control for his engine. Known as the flyball governor, this control, through an ingenious arrangement of two metal balls, a gear-train, and an escape valve, regulated the flow of steam to the engine. Thus, the engine regulated itself, permitting or impeding the flow of steam until a stable state of operation was achieved and maintained.[1]

Three years previously, in 1785, Oliver Evans, an almost completely unknown American colonist, invented what was to be the world's first completely automatic flour mill. Evans' mill was a one-man operation from start to finish. (Although the mill was eminently successful, Evans himself realized little profit from his historic venture.[2])

These two examples of prophetic technology stand out against a background of otherwise routine mechanization (if the advent of massive machinery and steam power may be termed routine). Brute power was a function of machinery, and the role of the human worker was to feed, assist, control, and maintain his iron helpmate. Chapter Two reviewed some of the social effects of this transfer of power from man to machine. The machines themselves required constant attention and maintenance and the exercise of human judgment all along the line. The raw product had to be fed into the machine, manipulated, and often relocated in order to facilitate the work of subsequent machinery. Finally, the finished or semi-finished product required moving and carrying to storage. Human

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[1]Harold Borko, ed., Computer Applications in the Behavioral Sciences (Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1962), p. 26.

[2]Carl Dreher, Automation: What It Is, How It Works, Who Can Use It (New York: W. W. Norton and Co., Inc., 1957), p. 41.

beings performed these tasks. Consequently, the operation of enormous and powerful machinery still depended on human judgment, without which, machinery itself was little more than organized piles of scrap metal. Although the locus of power had begun to shift from man to machine, the locus of control remained firmly under human jurisdiction even in those industries where workers would gladly have relinquished control for a measure of safety and comfort. The manufacture of nitro-glycerine, for example, was controlled by men sitting on one-legged stools. If the strain of unbroken concentration brought on drowsiness, they fell over and were immediately aroused.[1]

The Cost of Control.--If the worker had relinquished to the machine his right to mold, shape, and fabricate by hand, often he received from the machine compensations of another kind. His job required less knowledge of the art of handiwork, but it did require skill, often a great deal of skill, in the handling of complex and expensive machinery. Out of trial and error and much practice, the mechanical arts were born. Machinists learned to assemble and disassemble equipment, to make repairs, to improve design, and to anticipate and prevent mechanical failure.

For the ordinary worker the speed of machines greatly increased the hazards of work. Dexterity and the ability to make fast, responsible decisions were occupational assets. Mistakes of judgment were costly in terms of equipment and injury.

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[1]D. A. Bell, Intelligent Machines (New York: Blaisdell Publishing Co., 1962), p. 35.

The type of work that a man performed gave him his fundamental base in the community. It still does.[1] Working men sought employment in which they could take pride, and environment where they could drop roots and raise families. From their new skills they received a sense of purpose, a sense of direction, and a feeling of personal and social usefulness. The social life of the adult worker has always been patterned, in some degree, around his work.[2] In industrial centers across this nation the attitudes and interests of men and women were shaped by the quantity and quality of experiences afforded them, directly and indirectly, through the type of work made available to them.

The job, however, took its toll of human time and comfort. From "sun-up to sun-down" comprised the working day of the early 1800's. Literally, men toiled away their lives.[3] Time to eat and sleep; time to watch children grow; time to play; time to live; more time--this was labor's plea.

Working conditions, too, were the focus of some scattered and largely ineffective action. Fresh air and light, abundant in nature, were woefully lacking in most plants. Missing were the safety devices and precautions with which today's worker has grown familiar. For

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[1]Sebastian de Grazia, Of Time, Work, and Leisure (New York: Twentieth Century Fund, 1962), p. 238.

[2]J. A. C. Brown, The Social Psychology of Industry (Baltimore, Maryland: Penguin Books, Inc., 1954), p. 85.

[3]William J. Lavelle, Shorter Work Week (Pittsburgh, Pennsylvania: United Steelworkers of America, 1962), pp. 15-16.

example, the inhalation of noxious fumes was often overlooked completely. The factory system had one prime objective: production. Incidentally, men happened to be a part of the process.

Although machines did save production time, they consumed living space. Factory complexes sprawled across cities and towns, squeezing people into limited and crowded space. Generations of children grew up and matured in the shadows and slums of industrial centers. The social and health problems brought about by the shift of population from the Country to city have yet to be solved in many areas of present day America.

By reducing recreation and living space, the industrial system forced the worker and his family to look elsewhere for the means of play and privacy. The working man achieved a measure of satisfaction in his ability to purchase some of the products of his labor. Goods cost money, however, and only work made money available. More goods meant more work, and so the vicious cycle of earning and spending began. Thus, much of the time that was saved through the use of machinery was lost to the ordinary working man in the race to earn more money only to spend it on goods which city living made necessary.[1]

The seemingly endless trek from farm to city relentlessly pushed ahead through the 19th Century. Entire families packed up their possessions, and gave up the freedom of the land for the inflexible rigors of timed and mechanically paced work. When the supply of labor out-

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[1]Adapted, de Grazia, op. cit., p. 301.

stripped the demand, poverty and low wages inevitably resulted. Adolescent industry, still unsophisticated in the workings of capitalistic competition, often failed to foresee or forestall times of slack. The working man bore the brunt of industrial shortsightedness, for the cost of maintaining industry during periods of slow production was reduced by wholesale firings and lay-offs.[1] The hardships that must have followed need no documentation.

The Shift of Control.--In the past, technology advanced along a broken front. Accepted patterns of technological methodology were barely implemented, when someone, somewhere, devised an improvement, an addition, or a completely new concept of doing the same thing. If the time was not ripe, or the need for change not acute, revolutionary innovations gathered dust in patent offices and workshops, or if introduced at all, often failed because their significance was not grasped by commercial interests of the time.

While the world of industry busied itself fabricating whole items, an ingenious American, Eli Whitney, conceived the idea of mass production: the assembly of discrete and interchangeable parts into a functioning whole. He sacrificed the touch of craftsmanship and individuality for a less expensive, serviceable, and acceptable replica of the original.

In 1789, one year after Watt had introduced automatic control

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[1]L. Landon Goodman, Man and Automation (Baltimore, Maryland: Penguin Books, Inc., 1957), p. 133.

for the steam engine, Whitney contracted with the federal government to fill an order for ten thousand muskets. The shortage of skilled machinists plagued him. People there were who would leave the farm to work in his factory, but they were farmers, or unskilled immigrants, not mechanics. Whitney settled for the unskilled and semi-skilled labor available, but devised a production system suited to their abilities. Each worker was taught to be skillful in the making of a part of a musket. These individual parts were later assembled into complete items at the end of the production line.[1] Within two years the firearms were delivered to the government.[2] The world had passed through its first "tooling up" period in the shop of Eli Whitney, but apprently few, if any, industrialists of the time saw much future for the technique. Not until the late 1860's when the process was used in reverse in the dismembering of hogs, was the assembly line revived.[3] Upon these experiences, Henry Ford, in the early 1900's based his system of mass producing automobiles, and introduced industry again to the assembly line. This time, however, the technological climate was right for it.

The locus of control had shifted slightly. Under mass production, the human worker, although still in command of the machine, had

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[1]Dreher, op. cit., p. 39. (Adapted)

[2]Harold G. Bowen and Charles F. Kettering, A Short History of Technology (West Orange, New Jersey: Thomas Alva Edison Foundation, 1954), pp. 71-72.

[3]Paul T. Veillette, "The Rise of the Concept of Automation," Automation and Society, eds., Howard B. Jacobson and Joseph S. Roucek (New York: Philosophical Library, 1959), p. 8.

lost control of the whole product, or even the making of a meaningful sub-part of the product. The manufacture of goods was broken down into logical steps, machine and production logic, not human logic. The worker was assigned the task of making the same part, endlessly, and often without the knowledge of how or where his part fitted into the scheme of the whole.

With the loss of product control went loss of skill and theory, for the theory of the part is not the theory of the whole, nor is the skill of fabricating a part the skill of making relationships in a working whole. For the worker, the part became the whole. He was expected to find meaning in the meaningless, and out of monotony to invent challenge.

## Mass Production: An Impasse

Mass production is more than a mechanical principle. True, it involves the intricate organization of machinery, but perhaps more important from the human point of view, it also necessitates the organization of human beings for a common task.[1] As such, mass production becomes a social principle. That the commerce of nations, thus far in the history of Western civilization, has been intimately interwoven into the whole fabric of life, has already been suggested. Living and the means of making a living have never successfully been separated. The practice of mass production, then, was bound to have repercussions in the societal complex as a whole.

The social impact of mass production has been summed up rather

[1]Brown, op. cit., p. 38.

succinctly by Norbert Wiener. He states that what is used as an element in a machine, is an element in the machine.[1] (Italics mine.) In assembly line work the machine becomes more than a machine, a "man-machine," but the man becomes less than a man, a "machine-man."

The men and women at the conveyor belt did not find interest in their work. Indeed, there was little there to interest them. An inexperienced worker could be trained for a routine assembly line task in thirty minutes.[2] Often, the worker seldom deviated from this standard routine for the rest of his working life. Small wonder, then, that the orthodox view of work accepted by most managers and industrial psychologists was that work was a curse, a sort of Biblical punishment inflicted upon lazy and sinful humans who worked only to make money and who shirked their tasks upon the slightest provocation.[3]

Mass production in the United States, from the human standpoint, has not been in general a satisfactory system. It required of the worker a minimum of skill, and gave him little or no scope for individuality, judgment, or imagination.[4] In contrast to the professionals who gave their best efforts to the job, the men and women on the assembly line reserved their best for the time off the job. They sought to regain initiative, responsibility, and a sense of achievement denied to them by

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[1]Norbert Wiener, The Human Use of Human Beings (Boston: Houghton Mifflin Co., 1950), p. 213.

[2]Walter Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 101.

[3]Brown, op. cit., p. 186.

[4]Magnus Pike, Automation: Its Purpose and Future (New York: Philosophical Library, 1957), p. 182.

their work through vicarious leisure time pursuits.[1] If the job gave little status, the symbols of status could be bought.

Sebastian de Grazia points out that a person's free time is two things: what his work permits, and what his reaction to work dictates.[2] How free is free time spent in front of a television set compensating for a drab work life? Does a choice really exist in the nine out of ten households where television sets are turned on every weekday evening for an average of four and one-half hours?[3]

The impact of work on daily living is not a one-way street, for the quality of life is reflected back upon the quality of work.[4] Since the advent of mass production, the rise in absenteeism and quitting has risen noticeably, and the more fragmented the job, the sharper the rise.[5] "Slowdowns," "working up the line," "speed-ups," all are typical human reactions to an unbearable work situation.[6] Much of what was gained through assembly line work consequently was lost because plant designers, time and motion studies, and unenlightened management failed to take into account the human factor which, in the end, controlled production.

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[1]George Friedmann, The Anatomy of Work (New York: Free Press of Glencoe, Inc., 1961), p. 105.

[2]de Grazia, op. cit., p. 287. [3]Ibid., p. 113.

[4]Charles R. Walker, Toward the Automatic Factory (New Haven: Yale University Press, 1957), p. 208.

[5]Walker, Ibid., p. 205.

[6]Bernard Karsh, "Work and Automation," Jacobson and Roucek, op. cit., pp. 385-386.

Although the individual worker had lost control of the whole product, through massive labor unions he gained substantial control of the process. In many instances he could dictate to management not only the kind and quantity of his services, but also the price that must be paid for them. The great depression of the 1930's welded organized labor into a tough bargaining body. The memory of twelve million unemployed workers and their families, evicted from homes, living and dying in tar-paper shacks and tin-lined caves, brought solidarity to the ranks of labor.[1] Unions fought stubbornly, and scored many magnificent victories for the working man.

Management and labor, under mass production, worked themselves into an impasse. Neither could function without the other. As new and better machines were introduced into the production line, labor dictated how and where they were to be used. The bargaining table, the arbitration board, and compromise were accepted by both sides as better alternatives to the "lock-out" and the picket line.

While no one would deny seriously that Americans owe their high standard of living in significant part to mass production, to overlook the disadvantages of the system serves no useful purpose. Perhaps the most insidious aspect of mass production has been the complacence which it has encouraged among ordinary working men. In the past, most routine industrial employment required little, if any, formal education or training. An elementary level sufficed for most jobs, and if specialized training was necessary, the worker received it on the job. In terms of the amount of

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[1] Newsweek, April 1, 1963, p. 59.

time and effort spent in preparing for a lifetime of work, the average man, thanks to effective union leadership, was relatively well off. It was possible to maintain a satisfactory standard of living without investing time and money in formal preparation.

Opportunity to specialize, to prepare for the professions, and to advance oneself was available, and a great many workers took advantage of it. Still, the temptation to earn money was strong. Vast numbers of youths chose to enter the labor market when they came of age rather than invest in further preparation. Mass production appeared to make such preparation unnecessary.

Many of these same workers are today crowding our unemployment rolls. The slightest complication of the work pattern or environment caught them ill-prepared to meet change. Eighty per cent of all presently unemployed workers did not finish high school.[1] A recent survey of Chicago's unemployed disclosed the disturbing fact that fifty-one per cent of the jobless cannot read or write simple sentences.[2] In the sense, then that mass production encouraged a holding action rather than motivating a desire for vocational self-improvement, mass production must assume its share of the blame for the hapless circumstances in which millions of unemployed workers now find themselves.

The impasse of mass production, really an economic balance of power between management and labor, was contingent upon the retention of

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[1]Walter Buckingham, The Impending Educational Revolution, Occasional Paper Number One of the Educational Implications of Automation Committee (Washington: National Education Association, October, 1961), p. 4.

[2]Parade, November 11, 1962, p. 31.

control by the human worker. A dynamic technology, spurred by two world wars within a period of little more than two decades, had to expand. The only remaining area of expansion was into the realm of control. For all practical purposes, the locus of power had long ago shifted from human to machine. In 1947, a book with the rather strange title, Cybernetics, or Control and Communication in the Animal and the Machine, appeared in print.[1] Its author, Norbert Wiener, attempted to explore, among other things, the possibility of the control of machines by other machines. The age of the servomechanism was upon us, challenging human control of machinery, threatening to break the impasse of mass production, for if machines control machines, what is there left for the human worker to do?

## Detroit Automation

In the manufacture of automobiles, a certain number of production sequences remain fairly fixed. An engine block, for example, requires 6 millings, 21 borings, 265 drillings, 101 countersinkings, 106 tappings, and 133 inspections.[2] Positioning the block for machine tools to perform these operations, however, consumes as much time as the machining itself.[3] Because of the fixed nature of the machining and the similiarity of work pieces, the feasibility of rendering the entire process automatic was considered by the auto industry. Huge transfer machines, some as long as

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[1]Norbert Wiener, Cybernetics, or Control and Communication in the Animal and Machine (2d. ed., New York: M. I. T. Press and John Wiley and Sons, Inc., 1961).

[2]Goodman, op. cit., p. 45. [3]Ibid., p. 47.

football fields, were designed and built to serve this end.[1]

Transfer machines eliminate the need for human handling of the pieces during the machining process. The individual blocks are conveyed, or transferred, on a movable work table from station to station. As the pieces moves into position, it triggers a device that brings specific machine tools into action. Initial loading and unloading often require human power and judgment, but humans are eliminated from most of the intermediate steps.

This combination of mechanization plus mechanical and electric control has been called "Detroit automation," and it marks the first large scale use of machines to control other machines. Limited though it is, Detroit automation illustrated the mechanizing of long run or assembly operations where many tools performing diverse operations do their jobs swiftly and accurately with little human intervention.[2]

Human control, though diminished, is very much in evidence, however, in Detroit automation. The system is far from self-correcting or self-regulating. Human supervision and maintenance of machinery is required at all times. Also, because this advanced type of mechanization works best with standardized routines and products, any operations that deviates in any way from an operational norm must be handled outside the system through human judgment and effort. Detroit automation may be regarded, in a sense, as mass production, assembly line techniques carried to a higher level of mechanization, but with all concomitant operations,

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[1]Dreher, op. cit., p. 19.

[2]Reuben E. Slesinger, "Automation: Its Implications for Today's Economy," Social Science, April 1961, p. 102.

though mechanized, still present.

Detroit automation eliminates jobs. There can be little doubt about that. Experts were quick to point out, however, that these unemployment problems arose out of an unequal distribution of the labor force. If workers were not needed in one place, they were surely needed somewhere else.[1] It was simply a matter of matching labor with demand. After all, people have been losing and finding work since the Industrial Revolution.[2]

The thought is central to this study that the significance of Detroit automation lies not in the fact that it has caused some unemployment, or has replaced some human effort. Machines have been doing that as a matter of course since the Industrial Revolution. To evaluate Detroit automation solely in these terms is to overlook the most pertinent (and ominous) aspect of current technology. For the significant question is, what kind of human effort does it replace?

If Detroit automation replaces only human power, then some industrial economists are quite correct in assuming that it is merely an extension, a sophistication, of what has been going on for a century or more. And if this is true, then undoubtedly unemployment problems may possibly be cured by shifting labor from place to place. Somewhere, jobs will always be available.

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[1]W. Allen Wallis, "Some Economic Considerations," Automation and Technological Change ed. John T. Dunlop (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1962), p. 113.

[2]Jack Rogers, Automation: Technology's New Face (Berkeley: Institute of Industrial Relations, University of California, 1958), p. 73.

But does Detroit automation replace only human power? The most cursory of inspections will reveal that transfer machines, the heart of Detroit automation, eliminate human judgment along with power. For example, where to drill, how to drill, and when to drill are decisions no longer made by human workers. They are now functions of machine logic and mechanical motivation. In short, power machinery is now under the control of logical machinery. Except for the few curious examples previously noted, this situation has never before confronted the human worker, nor has the kind of unemployment caused by Detroit automation--the unemployment of human judgment--been experienced to any significant degree in the past.

Early in this chapter it was suggested that the manufacture of products involved the application of two vital forces to raw material, power and the means of controlling power. As machinery replaced human power, workers were often employed as control agents. Detroit automation represents one of the first organized efforts to eliminate human judgment from the control function. In this respect, Detroit automation forces a critical reappraisal of the human work effort. Any attempt to gloss over, to over-simplify, or to ignore underlying implications, does justice to neither the worker nor the work. For Detroit automation is only the initial skirmish in a new revolution, already underway, a revolution not only of technology but of thinking.

## Summary

Throughout the long history of Western civilization, manufacturing has been accomplished through the application of power to a raw

material. Power of itself is productively useless, however, until it is intelligently directed toward a predetermined goal. Power, in other words, must be controlled. Human muscle power under the control of human intelligence produced the goods and services which enabled ancient peoples to restrain and modify their environment.

As better substitutes for human power were found or contrived, they were so used. With the advent of the Industrial Revolution, however, wholesale substitution of mechanical for human power caught unprepared a great mass of human beings who were supplying industrial power of one sort or another in the fabrication of goods and in the performance of services. Adjustments to the demands of a new type of work were made slowly and painfully. Because the control factor was still firmly in human hands, however, when employment in supplying industrial power was not available there were alternatives involving the use of human judgment in the control of machines. Consequently, since the Industrial Revolution, there has been a steady shift in employment from human supply of power to human control of machines supplying power.

With the coming of mass production, inroads into the control function were made by machinery. The worker was often reduced to the status of machine tender who controlled the making of a small part of the whole product. The worker lost not only skills, but also the drive to maintain himself as an industrial asset. Detroit automation demonstrated the feasability of the control of machines by other machines. It resulted, to some extent, in the reduction of the value of human beings as organs of industrial control.

In the history of technology, human intelligence as the control factor in the application of power to a raw material has never been challenged. The failure of industry to capitalize on the historic ideas of Watt and Evans serves only to emphasize the point that control by machines, until quite recently, was a concept beyond the comprehension of most human beings. If machine control is today a reality, then such control represents a novel and radical departure from past performance. It is therefore reasonable to conclude that with the introduction of control machinery into the manufacturing process, a new and revolutionary concept of manufacturing has been instituted.

It has been stated that manufacturing, as the most important of the production industries, influences, directly and infirectly, the broad spectrum of work and life. The quality of change affecting manufacturing is bound to be reflected in other areas of endeavor, including social arrangements and human values. The full impact of Detroit automation must therefore extend beyond the confines of manufacturing. It is within this broader perspective that the real meaning of automation will be sought.

## CHAPTER IV

## THE MEANING OF AUTOMATION

"Detroit automation" is unique in that logical machinery is made to substitute for human intelligence in the control of power machinery. Logical machinery is a descriptive title reserved today for the general run of electronic computers serving a control function. In 1961 the computer industry in the United States passed the one billion dollar mark.[1] There are more than 20,000 computers in use in business and industry, in public and private institutions, and in governmental agencies. Their primary purpose is the "motivation" of people and machinery. For example, electronic data processing machinery (EDP) in commercial houses prepares printed documents whose objective is to influence the decision-making function of men or other machines. Computers in the manufacturing complex control the application of power to machinery, hence, decisions concerning the quantity and quality of processing fall directly within their sphere of responsibility.[2]

The purpose of this chapter is to explore the concept of control by machine, to examine the implications and underlying meanings of

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[1] Miami Herald, April 15, 1962, p. 2-C.

[2] L. Landon Goodman, Man and Automation (Baltimore, Maryland: Penguin Books, Inc., 1957), p. 57.

machine control, and from this analysis to arrive at a concept of automation which will have significance beyond industrial contexts.

In order to achieve these goals it will be necessary to investigate the electronic computer in its role as decision-maker. The kinds of computers now in use and their general functioning as logical machines will be described. Since the computer operates as a part of, or component in, a larger system, the nature of this system will be explored with the end in view of extrapolating systematization beyond the limited range of general current usage.

## Computer Applications

The industrial function of a computer is to control. The exercise of control, generally speaking, has always been a human prerogative. With the shift of the locus of control from man to computer, human beings have been challenged not only in an area which has traditionally been theirs, but also in an area which represents the final decision-making phase of fabricating goods or supplying services. Extrapolating machine control to its ultimate end, the role of the human worker as it has been practiced may be obsolescent.

Fortunately, the broken front assault of technology, coupled with the largely unpredictable tendencies of human business, make such extrapolations risky at best, and especially so in short-run terms. The long-run outlook, however, is something else again. Meanwhile, impressive gains in machine control are made daily.

Control by Machine.--Machine control is not a phenomenon peculiar to the

United States alone. It is spreading rapidly over the industrialized world, and especially in West Germany, France, and Great Britain. (The Soviet Union, too, has thrown the weight of its vast resources and technical talent behind the drive for more and better machine control.[1]) Typical of control installations is London's railroad operation. The largest transportation system in the world, the London complex was a nightmare of inefficiency and lost motion until the control of its 900 trains and 10,000 buses was relegated to computers.[2]

In the United States, the Chesapeake and Ohio Railroad saved a $900,000 order for flatcars just by utilizing a computer to keep track of the cars the company already owned.[3] The Social Security Agency, whose task it is to accumulate, store, and act upon vast quantities of data that must be kept up to date, uses three large computers to do the work of the million file clerks it once employed.[4]

Wherever large quantities of information must be dealt with, human control, in the past, has not proved to be completely satisfactory. The making of split-second decisions based upon all that is known about a specific aspect of operation seems not to be a function of human nervous tissue. In this age of astronomical numbers of people, goods,

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[1]K. Klimenko and M. Rokovsky, "The Technological and Economic Problems of Automation in the U.S.S.R." Automation and Society, eds. Harold Boone Jacobson and Joseph S. Roucek (New York: Philosophical Library, 1959), pp. 416-432.

[2]Walter Buckingham, Automation: its Impact on Business and People (New York: Harper and Brothers, 1961), p. 22.

[3]Warren R. Young, "The Machines Are Taking Over," Life, March 3, 1961, p. 112.

[4]Ibid., p. 110.

and services, computers appear to hold the key to effective and efficient deployment of effort, human and mechanical.

The industrial use of computers, in many instances, has revolutionized manufacturing. Not too many years ago, the fabrication of a finished automobile engine block from rough casting consumed twenty four working hours. Today the time has been reduced to little more than fourteen minutes. In 1908, a skilled sheet metal worker with hand tools worked eight hours to form the upper half of a fuel tank. Today the task is completed in twenty seconds.[1] Computer control of machine tools has been responsible for much of the drastic reduction of manufacturing time, making possible, in many cases, a more uniform product in a fraction of the time formerly required.

Nor has computer control been limited solely to industrial applications. A University of Oklahoma study of the survival rating of 445 heart patients pitted seventy three clinicians against a programmed computer. The results give some evidence of computer value in diagnostic tasks. The clinicians scored an average of sixty seven per cent correct diagnoses; the computer, ninety two per cent.[2] In an even more spectacular application to medicine, Dr. S. Gill of Ferranti, Ltd., Great Britain, forecasts the performance of surgery by computer-controlled machinery.[3]

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[1]Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 23.

[2]Stanley L. Englebardt, Computers (New York: Pyramid Publications, Inc., 1962), p. 104.

[3]Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 31.

It has been suggested, in fact, that much of the routine work of physicians, lawyers, teachers, and others could profitably be turned over to computers.[1] Some progress in this direction is already being made. In the United States alone, more than 3,000 physicians and engineers are collaborating in the production of clinical automata.[2] The present investigation of teaching machines and programmed instruction by the education profession needs no documentation. Computer applications in the behavioral sciences are steadily gaining headway with novel and revolutionary uses for the computer already demonstrated.[3]

Computers are serving many and diverse functions in the day-to-day lives of millions of people. Weather forecasts, for example, are of interest to most people. Yet, the preparation of a chart of a twenty four hour pressure-pattern requires thirty million mathematical computations.[4] Obviously, this task is ideally suited to computerization. Not so obvious, perhaps, is the utility of a computer in the answering of vast quantities of mail. Evangelist Billy Graham dispenses advice and stock passages of scripture to his world-wide congregation via punched tape and computer.[5] Truly, the use of the computer seems limitless already, and

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[1]Donald N. Michael, Cybernation: The Silent Conquest (Santa Barbara, California: Center for the Study of Democratic Institutions, 1962), p. 20.

[2]For a more detailed discussion see Murray C. Brown, "Electronics and Medical Education," Journal of Medical Education, Vol. 38, No. 4 (April 1963), pp. 270-281.

[3]See Harold Borko, ed. Computer Applications in the Behavioral Sciences (Englewood Cliffs, New Jersey: Prentice Hall, 1962).

[4]Goodman, op. cit., p. 77.

[5]Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 27.

yet the age of the computer has only begun:[1] an exciting, if somewhat ominous, prospect.

On October 4, 1957, the launching of the Soviet artificial satellite, Sputnik I, caught America completely by surprise. It shouldn't have, for the launching was announced in Russian professional journals weeks in advance.[2]

American scientists once worked for five years on a problem of electrical engineering that had already been solved and published by the Soviets.[3]

Human control of the mechanics of language translation was largely responsible for these oversights. With the volume of research reports already astronomical and increasing daily, the need for machine translations was critical. Today it is a reality.

Briefly, the computer as an instrument of control has replaced, and is increasingly replacing, human judgment in some areas of research, development, production, and services. The complexity of modern living plus the failure of human capacities to meet the demands of such complexity made the development of the computer a necessity.

The computer exists because it represents first, a saving not so much in the cost of human labor as in the cost of human control. A human being cannot be expected to respond to a given situation meaningfully

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[1]James D. Fahnestock, Computers and How They Work (New York: Ziff-Davis Publishing Co., 1959), p. 13.

[2]Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 28.

[3]Ibid.

and instantly, and in terms of full and relevant information. A computer does this as a matter of routine. The result is a substantial saving of time, material, and effort. Second, the manufacture of certain products such as those involving atomic radiation would be impossible without the computer. Third, the indirect cost of human labor (working space; fringe benefits, human relations) is substantially reduced.[1]

The impact of computerization is vividly illustrated in labor statistics. In 1919, twenty six million workers produced the goods used by a population of 105 million people. Today the population has increased to almost 190 million, but the same twenty six million workers produce the needed goods in a shorter week.[2] Thus, one of the costs of machine control has been the annual loss of 2.5 million jobs.[3]

## Computer Logic

The purpose of this section is to establish the general role of the computer as a decision maker, and to show, briefly and concisely, how computer decisions are formulated and implemented. Of necessity, oversimplifications will often obscure the complexity of process, for electronic computers are intricate labyrinths of circuits within circuits. Basically, however, their general function can be described, though perhaps not explained, in language meaningful to most people. For

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[1] Great Britain, Department of Scientific and Industrial Research, Automation (London: Her Majesty's Stationery Office, 1956), p. 14.

[2] Lester Velle, "Automation: Friend or Foe?" Reader's Digest, October, 1962, p. 104.

[3] Edward T. Chase, "Learning to be Unemployable," Harper's Magazine, April 1963, p. 34.

those who wish greater detail and technical elaboration, there are listed in the bibliography many excellent sources of information. Such treatment here, however, would not be germane to this section whose purpose is solely to describe processes, not to explain functions.

Although the word "computer" is often used as though it referred to a specific machine, the term is seldom useful until it is qualified in a way that names or infers a specific type of machine. Basically, there are two types of computers. Either or both may be put to work on the same or similar problems, but their means of arriving at conclusions are dissimilar. The <u>analog</u> computer solves problems by "standing in" for a physical or mathematical system. Resistors in an electric circuit, for example, may "stand in" for petroleum's resistance to flow through a pipe line. The <u>digital</u> computer, on the other hand, has been called a rapid "finger counter."[1] Electric impulses are used to perform arithmetical operations at speeds far beyond human capabilities.[2]

The role of both types of computers is, ultimately, to control. The analog controls by simulation; the digital by counting. Both apply principles of communications engineering to arrive at decisions effecting overt action, human, electrical, or mechanical.[3]

<u>The Analog Computer</u>.--The speedometer of an automobile is an analog

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[1] Jack Rogers, <u>Automation: Technology's New Face</u> (Berkeley: Institute of Industrial Relations, University of California, 1958), p. 30.

[2] Edgar Weinberg, "A Review of Automatic Technology," <u>Impact of Automation</u>, U.S. Department of Labor Bulletin No. 1287 (Washington: U.S. Goernment Printing Office, 1960), p. 7.

[3] <u>Ibid</u>.

computer in principle. It measures the rotation of a wheel and translates this into miles per hour. That is, a complete revolution of the wheel within a given period of time serves as an analog of a fractional part of a mile. This measurement is extrapolated onto a linear scale on the dashboard. The car's odometer serves a similar function, except that the measurements activate a digital counter which "remembers" the total number of revolutions in the form of numbers representing actual miles traveled by the car.

The guidance system of a "guided" missile is an analog computer. Changing states of air resistance, velocity, angle, time, etc. are translated into measurements of these factors, which are further converted into a chain of electrical impulses that activate control devices.[1]

In short, an analog computer makes measurements on a physical system (a slide rule, for example), and extrapolates these scale model measurements to the solution of the full scale problem.[2] In any analog system there is a direct correspondence between parts of the problem and parts of the computer.[3] An analog computer is wired to suit the needs of a specific problem. One might say, therefore, that the analog computer is "custom built" for every assignment, as indeed it is.

The application of the analog computer in the field is limited at the present time only by understanding and imagination. This computer,

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[1] Joseph Becker, "Computer Fundamentals," N. E. A. Journal, Vol. 51 No. 4 (April, 1962), p. 7.

[2] Willis H. Ware, "Digital Computers," Automation in Business and Industry, Eugene M. Grabbe, ed. (New York: John Wiley and Sons, Inc., 1957), p. 179.

[3] Ibid.

can be made to "stand in" for almost anything, a rocket, an aircraft prototype, an economic system, game strategy, the animal circulatory system, perhaps even the human central nervous system. The savings in money by "flying" new planes in the computer c nter, for example, rather than building an expensive series of prototypes is immediately apparent. Not so obvious, perhaps, is the kind of research that this computer makes possible. The possibility of simulating the behavior of complex organizations of many kinds by means of electronic hardware is an intriguing thought. Where it will lead, ultimately, is surely beyond the edge of imagination at present.

The Digital Computer.--Of the two computer types, the digital is most common. In fact, when the word "computer" is used without qualification, digital is often implied.

The digital computer, unlike the analog, does not deal with the physical system, *per se*, but with numbers representing the kind and degree of characteristics of interest.[1] A number of series of numbers, may represent anything, from the pulse rate of an astronaut to the vertical movement of a drill press. The most complicated digital computer, basically, adds or subtracts numbers. (Multiplication is done by successive additions, and division by repeated subtraction.[2])

Moreover, since the most efficiently designed digital circuits are for "on" or "off" states,[3] binary arithmetic (dealing with the digits

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[1]Ware, *op. cit.*, p. 179.

[2]Goodman, *op. cit.*, p. 63.

[3]Becker, *op. cit.*, p. 8.

1 and 0) has been found to be most useful in digital programming. A circuit is either "on" (1), or it is "off" (0). That is, electron tubes or transistors, used like electrical switches, respond to a series of ones or zeros by allowing current to flow (yes = 1) or impeding the flow (no = 0).[1]

The unit of information is the bit (short for binary digit), a coded series of ones and zeros that may stand for forms of information of the most diverse kinds.[2] A string of bits, for example, could activate one of several types of drills on a transfer machine, or represent the payroll status of an employee. Information is thus reduced to numbers, and as such, may be correlated to any other series of numbers in seconds. This correlation process is often referred to as computer "memory." Information in the form of bits is stored in such devices as magnetic cores, magnetic drums, perforated and magnetic tape, and others.[3] Incoming data are checked against all that the computer already "knows" or "remembers" and appropriate signals are transmitted to machinery or to humans to act in a predetermined way. All of this takes place often within a fraction of a second.

Perhaps the most unique feature of the digital computer is its "logic," that is, its ability to select one of a number of possible alternatives in terms of previous computations.[4] Because of the lightning-

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[1] Carl Dreher, Automation: What It Is, How It Works, Who Can Use It (New York: W. W. Norton and Co., Inc., 1957), p. 22.

[2] Ibid., p. 25. [3] Fahnestock, op. cit., p. 144.

[4] Becker, op. cit., p. 8.

like rapidity of operation, it is possible for a digital computer to review in an incredibly short time all of past "experience," and to base decisions on past outcomes of a similar nature. Fortunately, in Boolean algebra, a two-valued system of logic had already existed for nearly a century.[1] Computer programmers ingeniously combined binary numbers, on-off circuits, and Boolean algebra to program a logical "memory" into the computer.

Basically, any operation that can be reduced to a series of "yes" or "no" decisions, "go" or "no-go," can be controlled by a digital computer. The digital computer lives in a world of black and white. There are no shades of gray. A circuit is either "on," or "off;" it cannot be both at the same time. The digital computer cannot say "maybe."

<u>Digital or Analog</u>?--Not too many years ago the respective merits of the digital and analog systems were widely debated.[2] Although these differences have by no means been settled, it is generally acknowledged that both have certain qualities to recommend them. The digital system seems to require less skill in programming and operating. Since it deals directly with numbers, the magic aura of numbers surrounds it, for it is said to be more precise.[3] The analog computer, reduced as it is to saying "this much of this is analogous to this much of that," appears to lack the nice precision usually associated with numbers. However, as the analog computer gains wider use and understanding, the situation could indeed be

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[1]Irving Adler, <u>Thinking Machines</u> (New York: New American Library, 1961), p. 81.

[2]Goodman, <u>op. cit</u>., p. 53. [3]<u>Ibid</u>., p. 54.

reversed.

The analog system usually involves less associated equipment than the digital, and is therefore less expensive initially.[1]

Both analog and digital computers may serve as instruments of control. In this capacity, they qualify as agents of judgment and decision-making, for on their command, power is applied meaningfully toward the making of a product, material or non-material. Just what this implies needs further elaboration.

## Control as Self-Regulation

The term control as it has been used thus far in this study does not mean or imply dominance in the ordinary sense. Rather, computer control may be described in terms of motivation, in that a given set of events, interpreted in the light of computer "experience," triggers a mode of response that influences the behavior of the system under control. The end product of the system is therefore kept within tolerable limits, since any significant departure from established, predetermined norms will immediately illicit corrective action by the computer. In this sense, control implies "self-regulation" by the system.[2]

The ability of a machine or system of machines to control output on the basis of actual performance rather than expected performance has

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[1]Goodman, op. cit., p. 53.

[2]Stafford Beer, Cybernetics and Management (New York: John Wiley and Sons, Inc., 1959), p. 28.

been called "feedback."[1] To Norbert Wiener,[2] Ross Ashby,[3] and others who formulated much of the basis of cybernetics, goes most of the credit for what is known about self-regulation in the machine.

Wiener has defined cybernetics, rather broadly, as communication and control in the animal and in the machine.[4] The unit of cybernetic study is the system, a meaningful integration of components whose materiality is irrelevant,[5] but whose mode of systematization enables the system to maintain and enhance itself by providing the means for the acquisition, retention, and transmission of pertinent information.[6] Control is maintained through the dissemination of information, thus control is a function of communication. Consequently, the cybernetic system is held together through communication and control.[7] A car; a language; an ear; an equation--these are systems, and they can best be understood when the connection between their bits and pieces are studied.[8]

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[1]Norbert Wiener, The Human Use of Human Beings (Boston: Houghton Mifflin Co., 1950), p. 12.

[2]See Norbert Wiener, Cybernetics or Control and Communication in the Animal and the Machine (2d ed. New York: Massachusetts Institute of Technology Press and John Wiley and Sons, Inc., 1961),

[3]See W. Ross Ashby, An Introduction to Cybernetics (New York: John Wiley and Sons, Inc., 1956).

[4]Wiener, Cybernetics....

[5]Ashby, op. cit., p. 1.

[6]Wiener, Cybernetics..., p. 161.

[7]For a more detailed analysis of this relatively new, but highly provocative, point of view, the reader is referred to the many excellent texts on cybernetics, some of which are listed in the bibliography.

[8]Beer, op. cit., p. 9.

The computer is the controlling component in the industrial self-regulating system. By influencing the application of power toward a predetermined conclusion, and through a series of feedback loops which inform the computer of actual performance, the computer evaluates the product and regulates the behavior of the machines under its control. True self-regulation cannot exist unless, and until a machine system practices such self-surveillance.[1] Without control, an automatic machine (for example, an automatic washing machine) may or may not live up to expected performance, but the machine itself is powerless to discover and correct malfunctions.in actual performance.

Self-regulation is a new concept of production. Except for the few historic instances mentioned previously, self-regulation has never been a function of hardware of any sort. There can be little doubt that the control of machines by other machines is a technically new process.[2] That is implies a revolutionary re-evaluation of work is a distinct possibility.

## The Meaning of Automation

Self-regulation, where applied meaningfully to a process, is revolutionary not simply because it utilizes the computer as control agent (though computerization itself is wonder enough), but more important, because self-regulation makes possible the "work-system." It is understandable that the mech-electronic servomechanisms of today should out-

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[1]Dreher, op. cit., p. 24.

[2]R. H. Macmillan, Automation: Friend or Foe? (Cambridge: University Press, 1956), p. 91.

glamorize and obscure the very purpose for which they were originally intended: the integration of machinery. Popular and professional literature, while adequately describing in detail the wonders of today's machines, often fails to get beyond the machines and into the structure of work that makes such machines practical. The machine is merely the visible agent of the structure. Any understanding of the real meaning of present technology must be sought in the structure of the system, and not just in the quality and quantity of the mechanical and electrical devices that comprise the system.

A self-regulating system represents a way of processing that makes the best use of men, material, money, and machines. There is more than a technology involved here, for self-regulation requires a point of view regarding the place of human beings in the system and their relationship to machines. As such, self-regulation implies a <u>philosophy</u>. The philosophy of the self-regulating system must be sought in concepts of structure and order, in the design of basic patterns of implementation, and in the harmonious, balanced, and integrated mesh of parts into the flowing whole.

The self-regulating system is goal-seeking and goal-oriented. Moreover, through computerization, self-surveillance in terms of goals makes possible self-correction and self-enhancement. Lost motion and lost time are foreign to the system, as is conflict that disturbs the stable state of equilibrium.[1] The system is, in a sense, a dynamic living whole which seeks to maintain its own organization for the sole and predetermined purpose for which it was conceived and built.

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[1]Edwin G. Nourse, "What's New About Automation?" eds. Jacobson and Roucek, op. cit., p. 201.

There is no name, no word, in the English language that describes such a system. "Automatic" will not do, for this word already implies concepts long accepted and agreed upon (e.g., automatic phonograph; automatic elevator; etc.). Automatic devices, as already noted, are expected to perform in a certain manner. Generally they do. When they do not, usually they cease to perform at all. The self-regulating system is therefore more than automatic, and it is to this genre of system that the adjective "automated" is most meaningfully applied.

From the heart of the self-regulating system, then; from the harmonious blend of working parts into a single, integrated whole, arises the concept of automation. More than the computer and the machinery that it controls; more than feedback; more than technological change; more than lost jobs and new skills; more than self-regulation and control, automation stands beyond product and process, beyond human and machine, as a conceptual tool, a lively philosophy, that challenges both man and machine to be all that they can be.

Automation may therefore be viewed as a philosophy of process that envisions the harmonious integration of components into a single, self-regulating system. Automation is more of an idea than it is a technique, and as much of a faith as it is a technology. The challenge of automation lies in assimilating the system. The challenge of the system lies in its conception in human creativeness and intelligence.

Automation as a philosophy of process is readily discernible in the industrial setting because within this context it deals with tangible products, specific services, and hardware which may easily be manipulated. Looking beyond the specifics of manufacturing, however, and into the

concept of the self-regulatory system, we see that industrial automation is a consequence of systematization, and that self-regulatory systematization itself is a broad base from which other kinds of automation, not necessarily industrial, may arise. Any system of components, regardless of materiality, which exhibits such self-surveillance and self-regulation may therefore be termed automated. Under the terms of this interpretation of automation, a self-correcting economic system could be called automated, as could the animal respiratory system. As a philosophy of process, automation implies a way of looking at relationships between the parts of a system in terms of predetermined purpose. Automation only in the narrowest sense has industrial overtones.

## The Persistence of Ambiguity

The history of technology, like the history of human events of which it is a part, defies nice chronology. If men have learned little else in the past few decades, they have learned that ambiguity is here to stay. Nowhere is this more apparent than in the utilization of technology where the old and the new often dwell under the same roof. Although automation is an industrial reality, mechanization thrives still.

In spite of the fact that many industries (petroleum refining, chemical, and atomic processing) are truly automated in the sense that they are self-regulatory,[1] most of our industrial fabrication is still in the lower mechanization stage.[2] Hands and machines, guided by human judgment

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[1]Weinberg, op. cit., p. 6.

[2]Ralph J. Cordiner, "Automation in the Manufacturing Industries," Jacobson and Roucek, op. cit., p. 21.

and decision, account for the vast majority of America's consumer products and services. Not infrequently, instances of naked human power may still be found. Human muscle power for lifting, hauling, digging, and for countless other manual chores has managed to survive for a century and a half beyond the Industrial Revolution.

Data processing, the automation of paper work, has made tremendous progress within this decade. Accounting, procurement, inventory control, production scheduling and control, document handling, scientific and engineering analysis, management planning and reporting, all have been invaded by computerization.[1] Outside of certain manufacturing industries, in fact, the office holds the greatest potential for automation.[2] Yet, about half of our working population is still engaged in paperwork to keep track of what the other half is making or doing.[3] And in spite of automation, the number of office workers is expected to increase.[4]

To complicate further the total picture, moving beyond the United States, much of the rest of the world's industry is truly primitive. And even in those countries where industrialization has made some headway, paradoxes abound. For example, because of industrial crops such as cotton, Egypt's standard of living is reported to be now worse than under the

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[1]Herman Limberg, "Automation and Public Administration," Jacobson and Roucek, op. cit., p. 368.

[2]Paper by Director General to the 40th Session, International Labor Conference, U. S. Department of Labor, Impact...,p. 17.

[3]Miami Herald, April 15, 1962, p. 2-C.

[4]U. S. Department of Labor, Manpower, Challenge of the 1960's (Washington: U. S. Government Printing Office, 1960), p. 10.

Pharaohs.[1] Much of Great Britain managed to resist change and maintain pre-industrial status quo for periods of one hundred years or more. Some parts of Great Britain, in fact, have yet to institute changes begun six or seven hundred years ago.[2] And in spite of growing sophistication in electronics, the abacus is still the most widely used computer on earth.[3]

There are many reasons for the persistence of technological ambiguity. In the United States, some industries such as atomic processing could not exist without automation. Other industries, where choice was available, chose to automate or not to automate for economic reasons. The cost of learning to use EDP equipment in an office is as high as the original purchase price of the equipment itself.[4] Other industries by the very nature of their work cannot automate as yet. Still others who automated prematurely have discovered that if they had applied the same creative efforts to the old operation, many economies and advantages could have been achieved without new equipment.[5]

So it goes, the old and the new live side by side. Sometimes the new is pushed into practice before the time is ripe, but more often the old lives on beyond its allotted span to complicate, contradict, and confound pat theories and practices. The United States machine tool industry is a

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[1]J. D. Bernal, World Without War (New York: Marzani and Munsell, 1959), p. 46.

[2]Margaret T. Hodgen, Change and History (New York: Wenner-Gren Foundation for Anthropological Research, Inc., 1952), p. 67.

[3]Englebardt, op. cit., p. 18.

[4]Goodman, op. cit., p. 59.

[5]Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 101.

fair example of the latter. This industry, incredible for a country of this size and responsibility, is as yet an undeveloped area. The expense of operating outmoded machine tool equipment has, in many cases, priced our products out of the world market. One United States firm now markets machine tools in the United States that are designed by an Italian firm, and produced in Japan.[1] In an industry crying out for modernization, obsolescence still persists in spite of automation.

Still, change is everywhere. A look at present practices and past history, however, tends to confirm the view of many experts that this change will proceed slowly.[2] But on the other hand, short of outlawing the wheel; change will be relentless and persistent. The trend is toward the production of more goods and services with fewer workers.[3] The trend is toward the quality of change that will ultimately result in self-regulation for ever-increasing numbers of industrial systems. The ultimate objective of current technology is the fully automated enterprise.[4]

In the final analysis, however, the actual rate of change is, in reality, a critical imponderable. Current predictions have been based on the maintenance of existing practices and trends. There is more to prognostication, however, than applying a ruler to a trend line. The possibility exists of change occurring faster than predicted, faster than

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[1]Seymour Melman, The Peace Race (New York: Ballantine Books, Inc., 1961), p. 51.

[2]Macmillan, op. cit., p. 91.

[3]Paper by Director General to the 40th Session, International Labor Conference, U. S. Department of Labor, Impact...,p. 17.

[4]Macmillan, op. cit., p. 21.

current preparation for it. In the shadow of depression, in the decline of corporate profits, or in the event of major international hostilities, automation will move swiftly.[1] The technology already exists. If war comes, automation (born in the technological binge of World War II) will rage like wildfire through industry.

If war will upset the timetable of change, is a truly genuine peace desirable? It has been said that the greatest threat facing America today is not automation, but the chance that the Soviet Union may come forward with a genuine peace proposal that cannot be refused.[2] The modern industrial economy has been likened to a rocket that must continue to accelerate or fall out of the sky.[3] Peace could indeed be as costly as war.

If the rate of change cannot be predicted with the certainty one would hope for, certainly the nature of change should be more apparent. The shape of tomorrow is already being planned in the board rooms, the laboratories, and the inner offices of today. The signs have been posted. They need only to be read.

## The Future of Automation

Computerization will grow, and the computer derived technologies will be a major source of new employment in the near future.[4] An inevitable concomitant (barring some prompt and effective action by government

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[1]Dreher, op. cit., p. 13. [2]Melman, op. cit., pp. 82-83.

[3]Buckingham, Automation: Its Impact on Business and People (New York: Harper and Brothers, 1961), p. 155.

[4]Weinberg, op. cit., p. 24.

industry, and public education) will be the replacement and displacement of millions of workers.[1]

Not only will computerization grow, but computers themselves will undergo drastic metamorphosis. A major bottleneck at the present time is the inability to the computer to "think" in terms other than its own specially coded language. There is no way of feeding masses of ordinary typed or printed data directly into it.[2] This situation is expected to be remedied within the next few years. Already scanning devices to read pages of ordinary type and convert these to computer code are under development.[3] The next logical step, computers to understand the natural language of man, will not be far behind.[4]

The quality of computer "thinking," already precocious, will continue to improve. Although it is admitted that today's computer can learn and can exhibit original and purposive behavior,[5] the computer is often criticized for its inability to distinguish between the important and the trivial, for its lack of breadth.[6] This, too, will be remedied.

Tomorrow's computer will not merely "compute" numbers, but will

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[1] Some economists look for a 15% unemployment rate in ten years unless this action is forthcoming. (Time, May 31, 1963, p. 76).

[2] "Machines that Read," Dun's Review and Modern Industry, July, 1961, p. 27.

[3] Borko, op. cit., p. 599.

[4] Ibid., p. 602.

[5] Ulric Neisser, "The Imitation of Man by Machine," Science, January 18, 1963, p. 104.

[6] Ibid., p. 195.

actually manipulate symbols.[1] From the evidence available at the present time, there is every reason to believe that within the next two decades research and development will make available to industry machines that will do a credible job of original thinking of the quality now expected of average people who claim to "think" on the job.[2] But perhaps, equally significant, tomorrow's computers will operate in "real time."[3] Most computer decisions are today based on past events. A machine that will function in the present, that is, interact with events as they happen, is in the planning stage.[4] It will probably operate in nanoseconds (a new word in our vocabulary): billionths of a second.[5]

The Systems.--Computers are presently used to design and check the wiring accuracy of other computer systems (they have a better reputation for this).[6] It is also theoretically possible now to construct a self-reproducing machine. This interesting piece of logical "machinery" could construct a duplicate of itself by selecting its components from a large number of parts in a reservoir. Furthermore, if the reservoir contained parts of a more elaborate system, the Turing machine (as this automaton has been called) would be able to construct a more sophisticated replica of itself.[7] The systems built around such advanced computers surely stretch the imagination.

The computer center, a rather common sight now on most university

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[1]Borko, op. cit., p. 600. [2]Michael, op. cit., p. 9.

[3]Borko, op. cit., p. 600. [4]Ibid.

[5]Ibid., p. 598.

[6]Fahnestock, op. cit., pp. 18-19. [7]Beer, op. cit., pp. 179-180.

campuses, will, in the future, become just as common in the local community.[1] As people grow more knowledgeable about computer functions, the demand for computer "time" will increase. The prohibitive cost of computers plus their relatively rapid rate of obsolescence, puts them beyond the reach of the small businessman today. As cost drops with increased demand, however, and people learn how to use them, the public computer center will grow in popularity.

Some indication of what can be expected from tomorrow's automated systems may be seen today in the Aeroneutronic Division of the Ford Company. This organization has developed the Magnetic Integrator Neuron Duplicator (MIND), a thinking and learning system modeled after the synaptic junction of human and animal nervous tissue.[2] Increasingly, engineers are turning to animal functions in search of more sophisticated ways of building learning and retention into machinery.[3] A completely new science, bionics, is developing around this concept. Some of the early results are indeed remarkable. General Electric laboratories, for example, have produced the sharpest television reception yet known by copying the logic of the horseshoe crab's eye.[4] Conceivably, the thinking system of the future may be a sort of "hunch generator," modeled after the human brain, and working on probability theory, such

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[1]Goodman, op. cit., p. 72. [2]Englebardt, op. cit., p. 48.

[3]Earl Ubell, "Bioelectronics," Look, January 16, 1962, p. 51.

[4]Ruth Sheldon Knowles, "New Science That Copies Life," Saturday Evening Post, January 5 - January 12, 1963, p. 70.

as the human brain appears to do.[1] Tomorrow's self-regulatory system may be able to say more than "yes" or "no." Perhaps it may say, "Perhaps."

The Environment.--Within the next fifteen years the population of the United States is expected to increase by nearly one hundred million as an outside estimate.[2] Continuing this trend through the turn of the next century (just thirty seven years away), the total population could well be beyond the four hundred million mark. Four-fifths of this huge population will be city dwellers, many of them residing in twenty three gigantic urban complexes stretching for hundreds of miles in many directions.[3]

The explosion of knowledge will accelerate. The trend of the organized sciences and scientists, whose primary purpose is, basically, the manufacture of change, is expected to continue. The research team and the "group think" approach to problem-solving will have reached a level of sophistication difficult to imagine today.[4] It is likely that within the next twenty five years man will have created life in a test tube.[5] Because of new sciences such as bionics, blindness and deafness

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[1]W. Grey-Walter, "Studies on the Activity of the Brain," Circular Causal and Feedback Mechanisms in Biological and Social Systems, ed. Heinz Von Foerster (New York: Josiah Macy, Jr., Foundation, 1955), p. 31.

[2]U. S. Department of Health, Education and Welfare, Trends (Washington: U. S. Government Printing Office, 1961), p. 6.

[3]Henry Romney, "A New and Human Science," Sports Illustrated, March 28, 1960, p. 75.

[4]Leonard S. Silk, The Research Revolution (New York: McGraw-Hill Book Co., Inc., 1960), pp. 52-55.

[5]J. Robert Moskin, "Creation," Look, January 16, 1962, p. 44.

may be as obsolescent as polio.[1]

Perhaps more significant for the ordinary man, ways may be found to keep him informed of the tremendous advances in progress. The "information filter," a machine that would be taught by one person to select, process, and present only the information of his interest from the flood that pours upon him from all sources, may be a reality.[2]

A provocative issue under current discussion is the electronic amplification of human intelligence. It has been claimed that the work of genius, ultimately, is one of selection.[3] If intelligence is found to be "problem solving" in terms of selection, then intelligence may indeed be amplified.[4]

Ergonomics, the study of the human being in relation to cooperation with machines, may provide some answers to the place of man in an age of automata.[5] Clearly, the matching of the human body and brain to mechanized surroundings is already a troublesome problem. As technology grows, unless human characteristics are taken into consideration, some men may find themselves functioning as afterthoughts to other men's systems.

Archimedes said, "Give me a place to stand, and I will move the

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[1]Ubell, _op. cit_., p. 51.

[2]Kenyon Kilbon, "Machines That See, Hear, and Think," _Science Digest_, November, 1961, p. 26.

[3]W. Ross Ashby, "Simulation of a Brain," Borko, _op. cit_., p. 456.

[4]Ashby, _An Introduction to Cybernetics_ (New York: John Wiley and Sons, Inc., 1956), p. 272.

[5]D. A. Bell, _Intelligent Machines: An Introduction to Cybernetics_ (New York: Blaisdell Publishing Co., 1962), pp. 37-41.

earth."[1] It has been a myth of industrial management that technology automatically determines the standard of living. It springs from the ground, untouched by human hands, a product of nature.[2] The fallacy of this contention is apparent: man, not technology, is the causal factor. Man moves the earth. But he needs a place to stand. Giving men a place to stand, providing them with intellectual "elbow room," it will be shown, is one of the most crucial tasks facing public education today.

## Summary

Through the identification of the concepts of power and the control of power, in Chapter III, the nature of automation as a revolutionary movement was analyzed. Men have always controlled machines, but through revolutionary changes machines have begun to control themselves.

In the present chapter the concept of control by machine was examined. The role of the electronic computer as decision-maker in industrial operations was interpreted in light of basic processes which were of a self-regulatory nature. The basic processes identified in computer functioning were shown to have wider application than in the industrial context.

From this base, which underlies industrial automation, a point of view was developed which interprets automation as a philosophy of process involving self-regulating systems which has broad implications for many aspects of endeavor.

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[1]Quoted in Jerome S. Meyer, Great Inventions (New York: Pocket Books, Inc., 1962), p. 15.

[2]Rogers, op. cit., p. 74.

Technology as the product of human intelligence must have purpose and direction that arises out of the need to control and modify the environment according to some intelligent design. The future task of the human being would therefore appear to be the creation and assimilation of self-regulatory systematization toward the manipulation and exploration of his environment, the universe, for his own welfare.

# CHAPTER V

## LIFE AUTOMATED

Within this decade if all goes according to plan the United States will land men on the moon. Within this century moon travel will be commonplace. The writer represents the last of the earth-bound generations. Somewhere within our present keeping are the first navigators of outer space, the Magellans of the planets. Their exploits will dwarf a thousand centuries of human enterprise, although the enterprise of centuries will make possible their great adventure. The first space-age citizens of a space-bound America are today in our schools and nurseries. They will inherit not only the land as did we from those whose enterprise made possible our contribution, but also the limitless reaches of space. The gift of space is so unique in kind and so rich in potential that even the imaginations of the donors falter at the prospects.

Current technology, in significant part, made all of this possible. Through the discovery of unique technological concepts, Americans have handed their children and their children's children the key to new worlds. Equally important, today's senior citizens will soon vanish from the scene and leave behind them a host of concomitant problems for their progeny to solve.

The price of the new is often an agonizing reappraisal of the old. The clash of values, ever present in a dynamic society, is amplified a thousand-fold in our own because of the nature and rapidity of change. While we cannot know the exact nature of the problems which future generations will face, we do know that these problems will not be the same as our own. We do have the means of reappraising what we believe in the light of what we now know. We can anticipate and perhaps prepare the difficulties which seem inevitable. In public education, there is a current operation an organization whose task it is to post guide markers along the paths of our reflective choice.

The first order of business for the future should be the creation of a type of human being who can function effectively as a human being in an automated environment. He must be able to cope with machines on his terms, capitalize on their strengths, recognize their weaknesses, and in general, dictate the terms of the partnership.

The purposes of this chapter is to describe some general characteristics of the human being who will succeed in this task. The man himself, his work, his leisure, and the probable tone of his environment will be explored with the end in view of providing some general guide lines for the plans which must be made for his development. These characteristics are, of course, inferences drawn from current trends and practices extrapolated into the future. The danger of such inference making is obvious. If these inferences provide a beginning, however, something to stimulate thought and provoke a little action, they will have served their purpose.

## Tomorrow's Man

One significant observation for the future already has presented itself: if future generations of Americans are to prosper, they must come to terms with their machines. Complex machinery will be so much a part of their existence that the failure to do so could well mean either the end of technology with all that that implies, or the development of a type of mechanical human being few of us would want to know. Either men will control machines; or machines will control men; or men will destroy the machines because they cannot control them.

Within our own experience, there seems little enough to offer future generations, for in a sense we have ourselves failed to come to terms with machines. We have taken machines for granted, squeezing them into our lives wherever they seemed to fit, without bothering to plan intelligently for their use. For example, our crowded city parkways and our appalling accident rate reflect the lack of intelligent planning for the automobile.

Industrial planning has fared not much better. Our modern industrial society has been accused of growing randomly, helter-skelter, according to the chance of scientific discoveries and the whims of ideologies. It has lacked plan and purpose. The result has been the mastery of certain material processes and products without any real understanding of where or how they contribute to the general welfare of human beings.[1] Man, it seems, may know more about the chemistry of high

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[1]Adapted from Alexis Carrel, Man, the Unknown (New York: Macfadden Publications, Inc., 1961), p. 7.

polymers than he knows about himself.

This lack of over-all direction may indeed be the root of some of society's most persistent problems. Like a multi-dimensional amoeba of vast proportions, the modern society expands unevenly in time and space. Advancing here, lagging there, it absorbs, digests, and grows, apparently without benefit of concerted, intelligent determination. Our own ignorance of the place of human beings within this living organism reflects the complexity of the problems involved.

The insecurity of our relationship with machines is well illustrated in the current rash of machine humor. Cartoonists have found a ready market for cartoons depicting the sometimes irrationality of logical machinery. There is something in us that dislikes machines, and nothing seems to give us more pleasure than the sight of an expensive computer making a fool of itself. That it was a fool to begin with, seems not to occur to some of us. In the hidden recesses of our subconsciousness (and in spite of technological sophistication), the old fear of things mechanical still gnaws away at our insides.[1] This "Frankenstein syndrome" is not based completely on man's fear of creating a "thing" that will think like a man, for if machines thought as men do there would be no more reason to fear them than to fear men.[2] The fear is more fundamental. It is based on the possibility that a

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[1]A more detailed exploration of this theme may be found in Bernard V. Dryer, M.D., "Thinking Men and Thinking Machines in Medicine," Journal of Medical Education, Vol. 38, No. 2 (February, 1963), pp. 83-85.

[2]See Ulric Neisser, "The Imitation of Man by Machine," Science, January 18, 1963, pp. 194-197.

"thinking" something will be made which will <u>not</u> think as men do. And herein lies the real danger, for today's logical hardware does not think as men do.

As long as some men fail to comprehend the general nature of machinery, its purpose, its principles, its strengths, and its weaknesses, the old fears will probably persist. The preventive seems to lie in a mechanical orientation of all people whose lives are touched by technology. If we cannot live without machines, we must learn to live with them. Machines do not as yet have a completely independent existence. Man is still the causal factor. If he loses the initiative it will be by default, for the means of containing and utilizing machines are at his disposal. Computers with less mental capacity than a fish operate at near capacity while most of the human brain lies dormant.[1] More and better use of human intelligence may be an obvious way out of the mechanical cage which man has built for himself.

The successful man of tomorrow will be systems oriented. He will think in wholes. The interrelatedness and interdependence of phenomena will be apparent to him. Sometimes he will look back and wonder about the quality of thinking that made it possible for earlier people to categorize rigidly; to separate disciplines as though each existed for and of itself; to fail to grasp the order and "wholeness" of events. More than ever before; tomorrow's man will begin to see with clarity the vastness and complexity of his universe. His bold assaults into

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[1]Walter Buckingham, <u>Automation: Its Impact on Business and People</u> (New York: Harper and Brothers, 1961), pp. 32-33.

space, into the hitherto unassailable regions of his planet, and even into the unknown depths of his own being will be characterized by imaginative systematization of effort and information. Most importantly, because of this wholistic approach to observation and investigation, he will have learned to ask questions which do not seem to occur to us today.

The man of the future will be at home with machines. Regardless of his occupation, a superficial knowledge of the general functioning of most technical systems will be part of his experience. He will have learned the difference between himself and a machine, thus he will fear machines no longer. Unlike Charles Babbage who invented an automatic calculator back in 1822 but who could not write a coherent report of his invention,[1] tomorrow's man will be technically literate. Out of his deep understanding of the nature and role of mechanics will come a methodology for the lucid communication of ideas and functions.

The incompetent citizen, a menace mainly to himself today, will in the future be a menace to all. He will not be permitted to exist unrestrained. The integration of existing knowledge will facilitate the play of intelligence over a much broader field than is generally accepted today. Intellectual activity will come to embrace a spectrum of functions so wide and interrelated that the repercussions of unskilled thinking will be appreciated too fully to be tolerated long.

The professional man of tomorrow will have learned to cooperate

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[1] William E. Drake, "Automation and Education," Automation and Society, eds., Howard Boone Jacobson and Joseph S. Roucek (New York: Philosophical Library, 1959), p. 270.

and coordinate across the board with most areas of human enterprise. The economist, the mathematician, the social scientist, the physician, the educator, the engineer, all will be engaged in cooperative research and development on a scale scarcely hoped for at present. While the specialty will still exist, the cult of the specialist will gradually disappear.

Pure logic, as such, will become a function of electronic hardware. The quality of human thinking least appreciated today, the illogical and the insightful, may prove, in the long run, to be man's chief asset. As early as 1952 at a Symposium on Applications of Communications Theory, a genius was defined as a person with a strong noise source in his brain.[1] This was the reasoning that prompted the definition: the ordinary man, following the usual logic, will probably arrive at the usual logical, but often uninspired, conclusions. The person of unusual intellectual ability will tend to follow an illogical route, or proceed from premises exhibiting less than maximum probability. His conclusions will at least be out of the ordinary; at best, genius. While the man of the future will appreciate and utilize skillfully locial analysis, he will often relegate this task to machinery thus freeing himself to do that which man seems to do best, allow his fancy to encompass and explore the unknown, the unprogrammed, the illogical.

The man of the future will be adaptive and flexible, not in the

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[1]Reported by D. A. Bell, Intelligent Machines (New York: Blaisdell Publishing Co., 1962), p. 90.

sense of passively accepting change, but of actively ordering his existence in such manner as to take advantage of the unexpected and the fortuitous. The need for these characteristics is already apparent. Even the limited demands required of today's worker are often more severe than he can handle.[1] The successful man of the future will perform flexibly as a matter of training and education.

In a 1957 telecast,[2] a member of the Philadelphia Bakery Union complained, ". . . At one time we had plenty of work until the company eliminated all handwork and got a machine and a faster machine, and a belt, and now all they're puttin' out are cinnamon buns and they're just cinnamon bunnin' the public to death."[3] A characteristic of future man will be his lack of enthusiasm for some personalized services. He will want his goods packaged in a convenient form even if it means being "cinnamon bunned to death." One of the country's most successful restaurants has always been New York City's Automat where the customer seldom sees a waiter. The present crop of vending machines certainly point toward depersonalized service. R. H. Macy's electronic salesgirl may eventually replace the real thing.[4] The man of tomorrow will often sacrifice personalized service for the sake of convenience and efficiency.

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[1]George Friedman, The Anatomy of Work (New York: Free Press of Glencoe, Inc., 1961), p. 133.

[2]Quoted in Edward R. Murrow and Fred W. Friendly, "Automation: Weal or Woe?" eds. Jacobson and Roucek, op. cit., p. 223.

[3]Ibid.

[4]Donald Michael, Cybernation: The Silent Conquest (Santa Barbara, California: Center for the Study of Democratic Institutions, 1962), p. 17.

Depersonalization will broaden until it includes most routine services. For example, legal advice may come via computer. The idea of reducing cases to computer memory is already being studied.[1] The face-to-face contact with legal counsel may either be unnecessary or of short duration. In the field of medicine, the symptoms of every known disease may be stored in computer memory, and the computer itself will render diagnosis. (This innovation has been predicted for this decade[2]). The lawyer and the physician will be very much in evidence, however, but their personal services will be rendered in depth to exceptional cases that cannot be handled within the routine.

Low-cost, "walk-in" psychiatric clinics (already available in Los Angeles and Washington, D. C.[3]) will be commonplace in the future. Tomorrow's man, because of the nature of his work life, will undergo some severe adjustments. The "sleeping city" will be a thing of the past, for the working day will extend around the clock. Men will grow accustomed to odd hours of eating, sleeping, and socializing.[4] Available psychiatric services will help immeasurably in this transition.

Generally speaking, the man of tomorrow, because of the complexity of life and the magnitude of numbers, will surrender much of his individualism to the machine. This trend is already upon us. However, and this

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[1] Miami Herald, August 22, 1962, p. 5-B.

[2] Stanley L. Englebardt, Computers (New York: Pyramid Publications, Inc., 1962), p. 106.

[3] Robert P. Goldman, "Medicine: 1963," Parade, December 30, 1962, p. 4.

[4] See Bernard Karsh, "Work and Automation," eds. Jacobson and Roucek, op. cit., p. 338.

is most important, he may maintain and enhance himself as a person, as a specific individual. A visit to one's physician, dentist, counselor, barber, and even supermarket is fraught with waiting today, and crowned finally with little, if any, really personal service. Yet this writer would hazard the guess that most of the business being transacted is routine. The man of the future will be willing to submit his routine requirements to the machine thus reducing the work load of service personnel, and thereby insuring himself of truly personalized service when he needs it.

## Tomorrow's Work

Needless to say, the man of the future will work as did his forebearers. Contrary to come informed opinion, however, his work will not be an upgrading of today's skills.[1] In the late 1950's when the first wave of computers swept over industry, commentators and labor statisticians hastily concluded that henceforth industrial skills would rise to keep pace with increased technological know-how. That seemed to be a likely enough conclusion to draw at the time. With the coming of second generation computers early in the 1960's, however, a better informed reappraisal brought some different points of view.

Higher levels of mechanization seem to demand higher skills, but automation requires less skill because there is less to do.[2] Only the

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[1]For example, many of the case histories reported by the U. S. Department of Labor, claimed an upgrading of skills in newly automated plants. See also, Ewan Clague and Leon Greenberg,"Employment," Automation and Technological Change, ed. John T. Dunlop (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), p. 130.

[2]Buckingham, op. cit., p. 103.

job is upgraded, not the worker. Sometimes the worker assumes increased responsibility for expensive machinery. More often, as the work becomes more automated, the skill, effort, and even the responsibility of the job tend to decrease. The maintenance of equipment does create a limited demand for some skilled technicians, but this does little to offset the general trend.

Labor itself is today aware of this curious turn of events. Promised an upgrading of skills, labor finds that automation, in fact, is coming to the higher skills and reducing them rather than attacking the lower skills and raising them.[1] Some labor unions are taking the only recourse open to them at the moment, a shorter work week, in order to spread existing work.[2] Even the professions are not immune to skill reduction. The "half-life" of an engineer is today about ten years.[3] Dr. Thomas Stelson, head of the civil engineering department of the Carnegie Institute of Technology, estimated that a highly trained engineer working with mathematics could be replaced by a computer costing only eighty-four cents a day to operate.[4] The machine watcher, the technician who supervises machine operation, is disappearing. As cyberneticist Stafford Beer remarks, "The invigilation of automata is an absurdity...."[5]

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[1] William J. Lavelle, Shorter Work Week (Pittsburgh, Pennsylvania: United Steelworkers of America, 1962), p. 32.

[2] Ibid.

[3] Time, May 3, 1963, p. 88.

[4] New York Times, April 2, 1961, p. 12.

[5] Stafford Beer, Cybernetics and Management (New York: John Wiley and Sons, Inc., 1959), p. 101.

And it is absurd, for the technology that produced an automatic system may often just as easily devise an automated one.

The work of the future will involve the understanding of new principles, new processes, and new materials. Many of these will evolve from present projects, for example our space program, which has already produced revolutionary plastics and metals, exotic fuels, and completely automated systems. The future worker will be required to rethink through the work effort, to get outside product and process, as it were, and to view the big operation, the system. A premium will be placed on the men who can get the most from the system, the men who can understand the integration of component machinery, and analyze the enterprise in terms of what the system can do. The machine tender, chained to the drill press or the router, will be obsolescent, perhaps eventually obsolete. There will be little room for error in tomorrow's industry, and the quality of workmanship that may have contributed to the tragic end of the nuclear submarine Thresher[1] will not be tolerated. It cannot be tolerated, for too much will be riding on the outcome.

One of the curious aspects of automation is that it may often eliminate the very jobs it creates. As soon as an understanding of the purpose and function of a task is reached, the next step will probably be systematization where feasable. The only specialists who will survive

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[1]A court of Naval inquiry brought out this about American workmanship: the air-conditioning system on board the Thresher had been a continuing problem; there were errors in angle indicators that controlled diving; twenty per cent of the hydraulic system valves were installed backwards; plane and rudder mechanisms were found to be defective and replaced the day before the ship sailed; periscope mechanism was installed backwards. Reported by Ralph McGill, Gainesville Daily Sun, April 28, 1963, p. 6.

such a rapid turnover of skills will be those who specialize in change itself. Of the narrow specialist often encountered today, Dean of Columbia College David B. Truman says, "The specialist who is trained but uneducated, technically skilled but culturally incompetent, is a menace."[1] He, too, will be banished from tomorrow's world. He will be a luxury no one can or will want to afford.

In tomorrow's world of work the office will look like the factory, and the factory like the office. The multitude of typists, stenographers, file clerks, and machine operators associated with the usual office complex will give way to a single computer and its component equipment. A few technicians will be in attendance. The noisy factory, on the other hand, will also disappear, and in approximately one-fourth of its original space a new building will arise. Air-conditioned, clean, quiet, the new plant will work around the clock, attended and maintained by unhurried and unruffled workers in office dress.

Possibly one of the most disturbing aspects of tomorrow's work will be the isolation of the worker. In case studies of existing automated plants,[2] the great physical distance between work stations, the little opportunity for socializing, and the alertness demanded by the job has created much tension and uneasiness in the worker. Future improvements may reduce the need for constant attention, but in all probability

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[1]Time, February 15, 1963, p. 71.

[2]Floyd C. Mann, "Psychological and Organizational Impacts of Automation," ed. Dunlop, op. cit., p. 52.

the worker will remain in relative isolation. Some British workers have already demanded "lonesome" pay to compensate for the isolation of their jobs.[1]

More information and better retrieval systems will revolutionize the industrial management function. Routing decision making will be programmed into and handled by computers. Only exceptional circumstances will necessitate the intervention of the manager. Such managerial systems as IBM's Management Operating System (MOS) are now in use in some of today's businesses.[2] Under these plans, the entire industry, from start to finish, is computerized. The principle is "management by exception," with the computer carrying the daily load of routine decision-making.

The manager will rely heavily on a small group of key personnel, who in turn, will be equally dependent upon electronic equipment. The "line and staff" principle which grew out of mass production[3] will impede the flow of immediate and accurate information so essential to the efficient operation of automated plants. Consequently, "line and staff" will probably disappear from industry. With it will go much of today's middle and junior management. These are the managers in the "gray flannel suits," the social climbers, the New Yorker and Holiday set. They are also the innovators and the style setters.[4] At this time

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[1]Karsh, op. cit., p. 388.

[2]Englebardt, op. cit., p. 147.

[3]Buckingham, op. cit., p. 57.

[4]For a broader analysis of this view see Michael, op. cit., p. 20.

it is most difficult to foresee the possible effects of their disappearance on society in general.

The work of tomorrow, as we have seen, is emerging from the work of today. Most of the changes mentioned here are currently underway. Some will proceed slowly, others not so slowly. All will be profound.

As in every great undertaking, the beginnings of such changed concepts of work will surely be untidy. There will be confusion and bewilderment. They exist even today. The mental drain, especially in transitional phases of job enlargement and skill acquisition, will be heavy. As usual, there will be older workers who cannot keep up; others with strong ties to old communities who will remain immobile. There will be the non-adaptive, the timid, and the doubting. All exist today. The incompetents, too, will survive for a while, and society, for a while, will be tolerant of all. But in the end they will go, for tomorrow is for giants.

## Tomorrow's Leisure

Peace and prosperity, the good life so often sought by philosophers depends to a great extent on what people do with their free time. There is probably no better index of the quality of life than the use of leisure. Leisure is the time when people choose what they will do, not what they have to do. The choice, of course, reflects their values and preferences, and their society, regardless of outside appearances, is no better than the values upon which it rests.

As our society learns to assimilate automation, some sort of

equitable distribution of work among the labor force will probably be devised. The shorter work week with increased leisure time will be one way to do this. Not that this solution will suffice, for an expanding economy is still the best answer to unemployment,[1] but it will serve as a stop-gap measure until we learn to use and assimilate new technology. Ironically, a side effect of the shorter work week will undoubtedly be an acceleration of automation. The American people as a whole have shown little willingness to adopt a lower standard of living. Even with the shorter week they will want to maintain existing living standards, and probably will demand improvements. The only real solution, then, is more automation. Francis Bello of Scientific American states it this way, "If it is desirable that men have wealth without working. . . there can never be too much automation."[2]

In the transition of work from the old to the new, there will be little leisure for the professionals. They will be too busy systematizing, servicing, and managing. The professionals will find a substitute for leisure on the job as they have been doing for so long. Indeed, the prophesy of "leisure for the masses and work for the classes"[3] will, for a time, be fulfilled. As the agencies of society carry the ordinary man forward, however, the professionals, too, will find increased leisure time at their disposal.

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[1]Frank H. Cassel, "Educational Implications of Automation as Seen by a Business Executive," Automation and the Challenge to Education, eds. Luther H. Evans and George E. Arnstein (Washington, D. C.: N. E. A., 1962), p. 82.

[2]Francis Bello, "The Technology Behind Productivity," ed. Dunlop, op. cit., p. 168.

[3]Buckingham, op. cit., p. 175.

Because of the solitary aspects of automated work, much of tomorrow's leisure time will probably be spent in social activities. Active participation rather than passive watching will be the rule. Since the job itself will demand little physical (and possibly creative) effort, any activity that challenges the intellectual or physical capacities of the participant will be welcome. In the rush of new ideas, people will want, and find, some time to think for themselves, either in private or in small symposia where politics, the arts, science, and other activities inviting free play of the mind and imagination will be popular. Today, most people are willing to listen to lectures and concerts. Tomorrow, they will want to participate, and will do so with flair and vigor.

## Tomorrow's Environment

In the year 1963 this nation will spend \$14 billion on research and development.[1] By 1970, this figure will have doubled.[2] Most of this money will go into the manufacture of change which will modify, directly and indirectly, the environment, the living space in which we live. The "bigness" of appropriations for change will be matched by the "bigness" of change, and the "bigness" of events and the numbers of people which change effects. In fact, a great deal of this money will be spent on learning how to deal with "bigness" itself.

Business will be so big and the risks of business so ominous

[1] Business Week, December 29, 1962, p. 42.

[2] Harold F. Clark, "Educational Programs in Industry," eds. Evans and Arnstein, op. cit., p. 154.

that computer simulation will precede most important decisions.[1] Since the general population is directly concerned with the operation of government, to say nothing of the part people play in the success or failure of business itself, predicting the probably behavior of large groups of people will become increasingly important. A conceptual framework, called Leviathan, is already being proposed to handle this tremendous task.[2] As time goes on, computer simulation toward a theory of large groups will undoubtedly make present day surveys and samplings seem crude in comparison.

As is to be expected, many of the problems of tomorrow will have their roots in the nature of the environment, and they, too, will be big. Somewhere along the line a decision will have to be made regarding "machine directivity" and "machine docility."[3] When is the machine to direct, and when is the machine to be docile? Obviously, the answer to this question cannot be separated from the nature of the task, but just as obvious, ultimately a decision will have to be made somewhere by someone. On what will he base his decision?

What will come to be valued in such a society? Donald Michael

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[1]In fact, a whole new theory of business is growing around this concept. See R. Clay Sprowls, "Business Simulation," Computer Applications in the Behavioral Sciences, ed. Harold Borko (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), pp. 557-571.

[2]Sydney C. Rome and Beatrice K. Rome, "Computer Simulation Toward a Theory of Large Groups," ed. Borko, op. cit., pp. 523-554.

[3]Terms used by Don D. Bushnell, Information Retrieval Systems in Education, SP-734 (Santa Monica, California: Systems Development Corp., March, 1962).

suggests what the computer can handle.[1] Even more valued, however, will be that which the computer cannot handle, insight, breadth of vision, creativeness, and versatility.

There will be dangers, too, in this new society, and many of these will be environmental in origin. The press of "bigness" will often tend to distort perspective, and the temptation will be strong to shift the anthropocentric focus of life from man to machine. Pushbutton machines in the hands of pushbutton thinkers could bring about a super-rationalistic society devoid of risk and caprice, but equally devoid of free will, human values, and the right to "pull out the plug" when that seems best to do.

In spite of the dangers, however, the world of tomorrow promises to be as big, as brave, as exciting as the plans we make for the women and men who will populate it. In the last analysis, we, the citizens of today, face the fateful decision. We shall decide the kind of person who will inherit our land and the space beyond it. Our decision will reflect our deepest values.

## Summary

Because of the radical nature of change which automation will bring to the environment, problems of adaptation appear to be inevitable. The complexity of machinery and new ways of thinking demand a new type of human being who can function successfully as a human being in an auto-

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[1] Donald N. Michael, letter to the Editors, Science, March 22, 1963, p. 1232.

mated environment.

This chapter has described some general characteristics of the man of the future who will succeed in surmounting the problems of automation. Some characteristics of his patterns of thought, his work, his leisure, and the type of environment in which he will probably function were discussed.

It was pointed out that the successful man of tomorrow must come to terms with machines. He will be systems-oriented, will be adaptive and flexible, and will understand new principles, processes, and materials. He must learn to cope with isolation in his work and to make fruitful use of his leisure. Above all, he must face the crucial question of survival as a human being in an automated environment.

These characteristics were, basically, inferences drawn from current patterns and trends extrapolated into the future. They were offered here to stimulate thought and to provide some general guidelines for the preparation of future citizens who must learn to cope successfully with the complexities of tomorrow's automation.

## CHAPTER VI

## IMPLICATIONS OF AUTOMATION FOR PUBLIC EDUCATION

We have seen that automation, as interpreted in this study, is more than an industrial or engineering concept although the overt signs of automation are perhaps more evident in industry at the present time than in other activities. If one looks beyond industrial machinery, beyond the computers and the servomechanisms, one will find the fundamental concept of the "work system," the self-regulating integration of components that makes possible work without human intervention. It has been suggested that this concept of self-regulatory systematization has ramifications beyond industrial contexts. Any process which exhibits such systematization, physical, economical, educational, or other, may therefore be termed automated. Moreover, it is further suggested that the examination of other processes in terms of self-regulation may provide a different perspective from which to reassess previous conclusions. For this reason the writer proposes a concept of automation as representing a philosophy of process that envisions the integration of components into a single, self-regulating system.

Self-regulating systems do exist today, and the evidence is mounting that they will continue to multiply in the future. The industrial impact of automation has been explored with emphasis on the nature of change that automation is bringing to the job. We have seen

that the change in many cases is so radical as to be called revolutionary. Since work and life are closely interwoven, any change in the structure of employment is bound to have repercussions throughout the range of human activity. Automation is therefore changing not only work but society itself.

An attempt has been made to extrapolate current changes and trends into the future. Although there is much risk in this sort of prognosticating, it is a necessary part of planning for the future. We need to know where we have been, where we are going, what we shall find there, and what skills, attitudes, values we must develop in order to be successful in a world that promises to differ greatly from our own. In a sense, we have indulged ourselves in a sort of linear programming; that is, feedback from current technological patterns has been used to "feed ahead" in order to predict future needs that could not have been predicted solely from past performance or experience.

On the basis, then, of the kind of world that is emerging and the type of human being who must be prepared to live in it, this chapter will delineate those aspects of preparation for the automated world of tomorrow for which public education is responsible. The intent is to make meaningful and intelligible to educators the urgency of the times in which we live, and the necessity for public education to move bravely and resolutely into the new world which education itself helped to make.

Responsibility implies purpose, therefore the responsibility of public education must be sought in the purposes of public education in the American democracy.

Authoritative sources in the professional literature have set forth fundamental purposes of public education in the United States. With these purposes in mind, some basic criteria will be formulated from which implications with the regard to the concept of automation proposed in this study will be derived for public education. The implications will be applied to general education, curriculum and instruction, and educational administration. They will in no sense be conclusive, but are meant to serve as guide lines for future courses of action by the education profession.

## Criteria for Educational Implications

A society of human beings just by being and remaining a society is exercising preference. What it prefers, what it values, and the assumptions predicating these preferences and values form the basis of its philosophy, and give direction and meaning to its acts. Education, the process of facilitating the learning of that which will preserve and enhance both the individual and the society becomes therefore the fundamental base upon which all else is built.[1] Education serves all purposes,[2] and nothing worthwhile is made that is made not, at least in part, by education.

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[1]Harry R. Moore, Modern Education in America(Boston: Allyn and Bacon, Inc., 1962), p. 12.

[2]John W. Gardner, "National Goals in Education," Goals for Americans, Report of the President's Commission on National Goals, American Assembly, Columbia University (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960), p. 81.

Every educational aim is based on a prior axiological commitment.[1] Short-term goals dissolve into long-term purposes, and ultimately are resolved into value judgments concerning men and their relationships within a given frame of reference. Out of time and space and material, human and non-human, a society engineers what it chooses to value, and establishes schools to perpetuate its preferences and broaden its range of alternatives. As the range of alternatives increases, choice becomes a complex procedure, often demanding a reassessment and reevaluation of preferences if further action is to include the gain in new information. Thus, philosophy is dynamic, as is education whose roots lie in the value priorities of a given society.

Automation represents a significant gain in new information..It implies such a radical departure from traditional thought and ways of doing things that in order to realize its full potential, a shifting and realigning of societal values and preferences seem inevitable.

Public education exists in America; it is a going institution. Therefore its practices must be based on some prior axiological commitments. An inquiry into the nature of these commitments will perhaps provide a base from which to explore the quantity and quality of anticipated change.

The Individual in America.--From the beginning, this nation dared to be different: it values the life, the liberty, and the happiness of every man. To insure the perpetuation of these lofty ideals, our founding

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[1]Kenneth H. Hansen, Philosophy for American Education (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960), p. 113.

fathers gave to all, under law, equality of opportunity. To implement equality of opportunity, this nation underwrote education at public expense for all men. In spite of the fact that complete equality of opportunity has not yet become reality; in spite of some infringements of civil and personal liberties, this proposition stands as the most amazing pledge ever given by any government to its people.

A great deal has been written and spoken regarding the assumption that the individual human being is of infinite worth just by virtue of his humanity. Regardless of the basis of this assumption, be they metaphysical, political, economic, or plain hysterical, worthiness exists, in fact, under law. In the United States every man is worthy by statute. Education therefore has been relieved of the burden of assessing human worth, an awesome but discouraging task still prevalent in other nations. The mandate to public education in the United States is quite clear: equalize opportunity.

This mandate seems to be the soul of simplicity, yet it contains the seeds of confusion and conflict. How does an institution such as public education go about equalizing opportunity? Difficult enough in a homogeneous culture, the equalization process becomes a task of imponderable complexity in a nation that prides itself on being the "melting pot" of the world's humanity. Undaunted by the intricacy of its task, perhaps often unaware of it, public education in America for nearly two hundred years has striven to keep the founders' pledge. Noted historian Henry Steele Commager says, "No other people ever demanded so much of education as have the American. No other was ever served so well by its schools

and educators.[1]

The Equalization of Opportunity.--The end purpose of public education in the United States, under law, is the fulfillment of education's responsibilities in the equalization of opportunity for all citizens. In 1918, in a historic report to the National Education Association, the Commission on the Reorganization of Secondary Education presented the Seven Cardinal Principles of Secondary Education,[2] a breakdown of the total educational effort into seven, separate, though inter-related, areas of concentration. These are:

1. Health
2. Command of Fundamental Processes
3. Worthy Home Membership
4. Vocational Competence
5. Effective Citizenship
6. Worthy Use of Leisure
7. Ethical Character[3]

The Principles enabled public education to view and perhaps to treat separately what appear to be the major aspects of the educative process. It is assumed that if the person is helped to realize his full potentialities in all seven areas, opportunity for him and for those with whom he comes into contact will have been equalized. Further, with the

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[1]Henry Steele Commager, "Our Schools Have Kept Us Free," Views on American Schooling, eds. Laurence D. Haskew and Jonathan C. McLendon (Chicago: Scott, Foresman and Co., 1961), p. 128.

[2]Department of Interior, Bureau of Education, Cardinal Principles of Secondary Education, Report of the Commission on the Reorganization of Secondary Education (Washington: U. S. Government Printing Office, 1918).

[3]Department of Interior, Bureau of Education, Cardinal Principles of Secondary Education, Report of the Commission on the Reorganization of Secondary Education (Washington: U. S. Government Printing Office, 1918), pp. 10-11.

flowering of full potential, it is reasonable to expect that the person will take his place in a unique democratic community, prepared to enhance himself as a person, and to assume his responsibilities to others and to his society. Thus, to the extent that public education facilitates this growth, the equalization of opportunity will have been realized, and the obligation of public education discharged.

The Seven Cardinal Principles of Secondary Education proved to be a milestone in educational thinking, and to this time have yet to be replaced or substantially improved upon. In 1938, the Educational Policies Commission of the National Education Association again attempted to define the purposes of education in America.[1] The Commission established four primary objectives of education: self-realization, human relationship, economic efficiency, and civic responsibility.[2] An analysis of these objectives will disclose the original Seven Principles in new dress. In 1960, the Commission, asknowledging its debt to those who formulated the Seven Principles, saw fit merely to restate them, adding only that the rational powers of man must be developed in order to fulfill the Principles in fact.[3]

From time to time, education writers attempt to analyze the process of education in other terms and from other perspectives. For example,

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[1]Educational Policies Commission, The Purposes of Education in American Democracy (Washington: National Education Association, 1938).

[2]Educational Policies Commission, The Purposes of Education in American Democracy (Washington: National Education Association, 1938), pp. 39-48.

[3]Educational Policies Commission, The Central Purpose of American Education (Washington: National Educational Association, 1961).

Wiles and Patterson regard the high school as a public agency designed to provide experiences that will increase the personal, social, and vocational competences of all youth assigned through legal authority.[1] In a more recent publication, Wiles cites as the goals of classroom experiences, a developed intellect, commitment to a set of values, and good mental health.[2] James B. Conant in his familiar report on the American high school proposed citizenship, useful skills, and proficiency in advanced academics as criteria for determining the effectiveness of the educational effort.[3]

Professional education, perhaps more than any other discipline has received the benefit of a great deal of opinion and thought from without the profession. Walter Buckingham of the Georgia Institute of Technology sets these goals for public education: mental flexibility; skills for developing logical, analytical, and quantitative thinking; creativeness; receptiveness to new ideas; and emotional maturity.[4] Lee A. DuBridge of the California Institute of Technology states the aims of education in terms of an understanding of the modern world; prepa-

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[1]Kimball Wiles and Franklin Patterson, The High School We Need, Association for Supervision and Curriculum Development (Washington: National Education Association, 1959), pp. 2-3.

[2]Kimball Wiles, The Changing Curriculum of the American High School (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), pp. 150-151.

[3]James B. Conant, The American High School Today (New York: McGraw-Hill, 1959), p. 15.

[4]Walter Buckingham, The Impending Educational Revolution, Occasional Paper No. 1, Educational Implications of Automation Committee (Washington: National Education Association, October, 1961), p. 12.

ration for work and career; and fruitful use of leisure.[1] AFL-CIO's Stanley Ruttenberg, in a scathing criticism of public education's failure to meet current vocational demands, declares the school to be responsible for equipping all citizens, old and new, to meet the needs of a social and economic revolution now underway.[2]

Stripped of the terms of urgancy, and overlooking the possibility of one or more areas being overemphasized at the expense of others, the various goals and aims of public education cited above ultimately may be assimilated into the general framework of the Seven Cardinal Principals. Different times and different needs of course necessitate a reorientation of the Principles, but nevertheless the original grouping appears still to stand intact with relevance for our time. The only real innovation may be Mr. Ruttenberg's intimation that perhaps public education has a responsibility toward senior citizens. This idea does not alter the basic structure of the Seven Principles, but merely adds a new dimension to public education in general.

The Seven Cardinal Principles of Secondary Education, as stated by the Commission on the Reorganization of Secondary Education, are among the most significant guide lines for American education today. They represent the highest aspirations of our people for the education of youth, and, if rigorously and imaginatively implemented, will lead to the

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[1]Lee A. DuBridge, "Educational and Social Consequences of Automation," Automation and Technological Change, ed. John T. Dunlop (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), p. 41.

[2]Stanley H. Ruttenberg, "Educational Implications of Automation as Seen by a Trade Union Official," Automation and the Challenge to Education, eds. Luther H. Evans and George E. Arnstein (Washington: National Education Association, 1962), p. 94.

equalization of opportunity for our youth. President Kennedy in a recent address to the students and faculty of San Diego State College said that the nation's education goal must be "a system in which every child. . .has every opportunity that his abilities and character deserve."[1] The implementation of the Seven Cardinal Principles will facilitate the realization of this goal. They have withstood the tests of time and scrutiny for nearly half a century. That they have relevance for the revolutionary era in which we live, serves only to emphasize the observation that the job was well done in the beginning.

It is recognized that the educational effort cannot so easily be categorized into seven areas, for the one runs into the other. As the statement of purposes of American education, known as the Seven Cardinal Principles, was offered in 1918, so will it be used here: as an arrangement of convenience. If educational effort and resources are to be deployed effectively and efficiently, some such arrangement must be made.

The educational implications of automation will therefore be analyzed and expressed in terms of these Cardinal Principles. Each Principle will be examined in the light of what has been said of automation and the quality of change expected to accompany it. The implications that will be drawn appear to be most significant to the writer at this time. Undoubtedly, there are other implications of equal or more importance which may be passed over. Attention is directed to the type of inference, however, and not necessarily to the number.

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[1]Associated Press Dispatch quoted in Gainesville Daily Sun, June 6, 1963, p. 1.

## Implications for Public Education

One of the most crucial tasks facing public education at the present time is to determine the function of schools in a society which is rapidly changing. The old and the new vie for priority of attention, with advocates and extremists of both points of view pressing on all sides for public education to take a stand on issues of importance. While schools do have a responsibility for facing the challenge of new and revolutionary events, they also have an obligation to maintain and foster values and ideas of proven worth. In meeting this challenge of achieving balance and counterbalance between the demands of the old and the new; in the maintenance of equilibrium, and, through intelligent interpretation of feedback, seeking new states of equilibrium, public education may maintain itself as a dynamic, purposeful system.

It is easily seen that in fulfilling this function of systems maintenance, public education will face a continuing barrage of criticism and attack from all sides. In his role as agent of balance and counterbalance, the professional educator will be at the same time, most vulnerable, yet most useful. If public education is to fulfill its responsibilities, however, it must learn to deal with opposing pressure interests; know when to move forward; know when to hold fast; and most importantly, learn to act on the basis of the most complete and reliable information available.

The implications of automation for public education which follow will not attempt to review those current practices of educators which appear to be successful. The existence of public education itself and

the sympathetic support of government, business, and the vast majority of people prove more than words that public education, in general, is not only meeting its obligation, but meeting it with vigor and intelligence. To recount these successes at this time would detour the study around events which have been documented fully in professional literature. There are some areas of crucial importance where public education appears to need new direction, however, and it is precisely to these areas that the implications of automation will be directed. The intent is to sensitize educators to zones of weakness. The great strengths of public education will, of necessity, be passed over, Their existence, however, will be assumed, for it is the strengths of public education which make the weaknesses apparent, and which offer direction for remedial action.

Health.--Human beings have never before faced the scope and rapidity of change which have been predicted for the near future. If our society is to survive and prosper, a passive endurance of change is not enough. Citizens must learn to welcome it, use it, and create it in order to fulfill themselves. Yet, change is one of the most unsettling aspects of living. In reconciling these two paradoxial forces, the inevitability of and resistance to change, public education will have done much toward the maintenance of sound health, mental and physical, for students.

A healthy perspective of change will grow out of the student's self-confidence and self-assurance, and the knowledge that he has prepared himself to meet change. The school must support him; help him to identify his strengths and make the most of them; encourage him to discover and remedy his weaknesses; assist him in aligning his values, his

responsibilities, and his rights.

The school must develop a program that will help the student to acquire basic understandings and learnings compatible with the requirements of an automated environment. To transform threat into challenge, the student will need new skills, new attitudes, and a new perspective on life. The primary function of the school is to provide the quality and quantity of experiences which will enable the student to make this transformation efficiently and effectively.

The results of unpredictable change will be perhaps more apparent with reference to mental health. The national figures compiled on the incidence of breakdown of mental health among the general population are appalling. Two hundred thousand new patients yearly are admitted to mental institutions in the United States.[1] Probably the same number or more walk the streets without treatment. If their condition was in part brought about by the anxieties of modern living, then indeed we have a problem, for the complexities are only beginning. Ours is a tense and anxious world. Unless we learn to deal with complexity and ambiguity we may yet forfeit the world of tomorrow which promises complexities the likes of which we can scarcely imagine. Public education can do much toward the reduction of anxiety by creating an environment, relatively free of personal threat, where the complexities of life may be examined and discussed openly. The least that public education can do is to refrain from contributing to existing anxiety.

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[1] Parade, January 27, 1963, p. 15.

The current emphasis on increased standards for academic achievement, the "talent search," the widespread use of standardized testing programs, the acceleration of groups of students, and the introduction of advanced subject matter in increased quantities and at earlier stages of pupil development - all of these facets of a deep and unnerving force toward academic achievement raise questions about the probability of effect upon the mental health of pupils. Ultimate results cannot be foreseen.

In Japan, for example, during the week-long scholastic examinations in Autumn, the suicide rate climbs. Failure in scholastic achievement accounted for 137 such suicides in 1961.[1] American students have learned to assess the opinions of academicians more realistically, but nevertheless the hardships of unnecessary anxiety and threat in our schools will never fully be known. Nor can we expect relief until the education profession learns to distinguish between rating and evaluation, between product and process, between the important and the trivial.[2]

There has been a steady and phenomenal accumulation of significant research, particularly in the past three decades, from fields of investigation in the various biological and social sciences which forms a base of operation for the development of sound educational programs, incomplete though our knowledge of the human being may be.

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[1] Miami Herald, August 19, 1962, p. 23-A.

[2] For a dramatic example of the results of threat and anxiety in students see William D. Hedges, "Changing the Behavior of Graduate Students in Education," Phi Delta Kappan, Vol. XLIV, No. 9 (~~May~~ June 1963), pp. 447-449.

In coping with the forces for academic achievement, the significant implications of behavioral science research must not be overlooked. Nor must the schools look far afield for immediate courses of action. They need only implement what is already known about the nature of human nature and human growth and learning.

The current national concern with physical fitness indicates an area of weakness where public education may be able to do more toward the maintenance of sound health. In acquiescing to the demands of a loud pressure group, public education often finds itself in the position of sports promoter to the community, sometimes at the expense of adequate programs of physical education for the majority of students. Public education must not let itself be caught in this trap. The monetary returns of such sports promotion are trivial in comparison to the long-range losses in national health and public support of entire school programs.

We need to see an end to mass spectator sports in our public schools, not because of their unimportance, but because of their great importance. They are, in fact, too important to be shared only with a few trained athletes while the bulk of students is relegated to passive watching and the exercise of their vocal mechanisms on the side lines. We need to see the gymnasiums of public buildings thrown open to the public for its use, not padlocked until basketball night. (A basketball court is not a gymnasium, not even with a few mats, a climbing rope, and a set of parallel bars). There is an urgent need in our schools for programs of physical fitness, and personnel to administer them. There is less need for the coaching specialist, and no need whatever for the cult

of coaching that is practiced even in many junior high schools.

Good habits of physical and mental health are neither learned nor practiced in a vacuum. They are a vital part of life, and have little meaning until we live them. The world of tomorrow will demand great mental stability and a sense of proportion. These characteristics have not been known to arise out of unreasonable and unnecessary threat and anxiety.

In an automated world, the characteristics of which have been analyzed in this study, there is a need for a positive, comprehensive concept of physical and mental health as related to the all-round well-being of individuals. True, there will continue to be need for remedial and corrective procedures, but a sound educational program designed to help individuals cope with the complexities of tomorrow's world must rest upon not only a preventive viewpoint but a positive view of the healthy person.

Command of Fundamental Processes.--The fundamental processes, those elements of curriculum content which develop the rational powers of man, have been regarded, traditionally, as reading, writing, and arithmetic. Assuming for the moment that this is so, the changing quality of the environment would also be reflected in these fundamentals, perhaps even more so in them. This means that reading, writing, and arithmetic experiences would have to take into account the nature of the revolutionary times in which the student lives, and the demands that automated living makes upon the student in terms of these fundamentals.

For example, reading. An automated environment calls for a broad,

comprehensive knowledge that cuts across many fields of endeavor. How else is the student to gain this comprehension if not, in significant part, through reading? But this sort of reading implies a search for deep meanings, which in turn calls for useful vocabularies and the ability to retrieve and select pertinent information from the incredible volumes of information impinging upon the senses from all sides. Once selected, information must be processed meaningfully and related to other information in order to form intelligible "wholes" which then become the basis for action. In this sense, reading is as fundamental today as it ever was. Unless the quality of automated living is reflected in reading experiences, however, reading may be called fundamental without touching upon those requirements of daily living which make it fundamental.

A similar point of view may be offered with regard to writing. The purpose of writing, or for that matter any system of symbols, is to communicate ideas with the least amount of ambiguity. This calls for the type of writing experiences which encourage clarity of thought and lucid, analytical development of ideas. In the press of time and change, students must be helped to express themselves tightly and with brevity, without sacrificing meaning. This idea is not new; it has always been the secret of good writing. Automated living simply demands that good writing, in this sense, become the mark of every man, and in this sense only, is writing fundamental.

It is doubtful if any previous civilization relied so completely on mathematics as our own. Not only is mathematics at the heart of our technology, but it permeates our lives and promises to remake our world. A fundamental knowledge of quantitative concepts must therefore become

part of every student's experience. But to earn the title of fundamental, however, mathematics must provide the student with the sort of conceptual background necessary for understanding the place of mathematics in the scheme of automated living.

For this reason, a new kind of mathematics seems necessary if more people are to become as proficient in this area as they must. In the past, there has been too much stress on production, too little on meaning. Most computers can be programmed to do intricate calculations involving the application of known formulas. To stress these calculations exclusively in mathematics classes may be an unfruitful use of time. What is needed, especially for those students whose use of mathematics may be peripheral, is the type of course work designed around the use of mathematics as a conceptual tool, as a means of translating the most diverse types of problems into terms which the computer can handle. When such approaches are developed, they should become a part of every student's program, and should be required at every level through graduate school. If the gap between the ordinary citizen and the computer-oriented scientist is ever to be closed, then an understanding of the general functioning of today's mathematics seems essential. Only as mathematics serves these needs is it fundamental.

In light of what is known about the nature of an automated environment, there appear to be fundamentals other than the traditional 3R's, however. Dr. Klaus Fuchs, the eminent atomic physicist who defected to the Soviets, was a brilliant man, undoubtedly skilled in the 3R's. Unless there is a firm moral commitment to democratic ideals, however, and

a lively faith in the worth and dignity of the human being, reading, writing, and arithmetic serve no democratic purpose. Computers to read, write, and do arithmetic are already in use. These skills are fundamental to machinery of this sort. There are prior fundamentals, more fundamental fundamentals which men living in a democratic society must subscribe to. Unless these take precedence over basic skills, the skills themselves may be used to destroy the very ideas they were supposed to enhance. The fundamental processes in an automated, democratic society must include a fourth R, revolution, the meeting of demands of a revolutionary age. More than reading, writing, and arithmetic must go into the fundamental education of the rational man if democracy is to survive.

The present concept of fundamentals must be broadened to include experiences which develop a moral rationality based on the axiological commitments of our way of life. There is a difference between a Soviet mathematician and an American mathematician, and this difference must permeate the student's experiences in school. Automation is progressing as rapidly in the Soviet Union as it is in the United States. The purpose of automation should be different, however. In an automated world of logical machinery, teaching the fundamentals as they have been traditionally taught and traditionally known is not enough. There are no fundamentals apart from direction and purpose.

Worthy Home Membership.--The family as a traditional social and economic unit seems to be disappearing. In fact, the Family Service Association of America claims that the prime social problem in America today is the disintegration of the family.[1]

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[1] Parade, January 27, 1963, p. 15.

The family has been prized in American tradition. It should not be permitted to pass from the scene by default, at least not until a worthy substitute is found. The possibility does exist, however, that the family, like affected individualism, is a vestigial adornment of a vanishing way of life. Perhaps we are clinging to a social arrangement that is gradually losing its usefulness.

The reasons for familial breakup may be many. One of the more obvious is economic. The effects of automation are more easily discerned here. One mother out of every five works today.[1] Jobless youth, desperately in need of money in order to fulfill themselves in a society that prizes it so highly, are an explosive situation beyond family control.[2] Money problems are at the root of the one out of every four marriages that ends in divorce.[3] Divorce means children living with one parent or with no parents. Lack of parental influence undoubtedly contributes to delinquency and illegitimacy rates which have tripled since 1940.[4] All appear to be both cause and effect of family disintegration.

The most significant implication of automation for the family seems to be an acceleration of the forces which are now jeopardizing its existence. With continuing high unemployment rates that force mothers to work in order to supplement low or no incomes and with the predicted

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[1] Wiles, The Changing..., p. 45.

[2] Miami Herald, May 12, 1963, p. 19-A.

[3] Parade, January 27, 1963, p. 15.

[4] Ibid.

increase in unemployed youth, the initial thrusts of automation could deal the family a serious blow. Coupled with the anticipated twenty four hour work operation that will require odd hours of family socializing (if and when entire families can get together), these forces, in the end, could transform the family into a social and economic liability.

Even more ominous are the psychological consequences of family disintegration. A completely satisfactory substitute for the human family has not yet been found. In spite of meticulous care, for example, children born in the baby farms of Nazi Germany during World War II were mentally and physically backward. Dr. Hellbruegge of Munich University's Pediatric Clinic blames the deficiency on psychic starvation; lack of parental love and affection.[1] P. B. Medawar suggests a similar causal relationship between children of large families and their generally lower intelligence scores.[2] Until such time as the molecular structure of love is discovered and synthesized, the family appears to be a necessary part of the growth and development of healthy, human offspring.

The school and the family have traditionally functioned as delicately balanced components within the educational system. The one reinforced the other, and through open and adequate channels of communication, information was fed back and forth, thus maintaining the equilibrium of the system. As the social scene changed (due in no small part to changing patterns of unemployment), the public schools assumed more

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[1] Miami Herald, May 20, 1962, p. 12-E.

[2] P. B. Medawar, The Future of Man (New York: New American Library, 1959), p. 82.

and more of the family's responsibilities as broadened concepts of curriculum. School and family drew apart, and the result has been an interruption of the flow of communication between school and family with consequent vagueness concerning the function of the school in some crucial areas of youth development.

Certain obligations traditionally discharged by the family are not now being met. Morality, spirituality, loyalty, to name a few, are left to develop haphazardly, if at all. Although the church assumes responsibility for some of these obligations, the family has usually been instrumental in persuading youth to attend church. With the waning of family influence, however, there are many youths that the church cannot reach. In a recent New England survey, only one out of three children attended any church at all.[1] Clearly, there are areas of youth development for which no one claims responsibility.

Information is a measure of organization in any system. Disorganization usually is the result of little or no information, or misinformation, within the system. The immediate task of the school is to open adequate channels of communication between family and school. Until this is done, other measures will not be fruitful, and could possibly accelerate the disintegration of the system. Once communication is re-established, the school must move toward a more stable state of equilibrium by bringing relevant information to bear upon the division of responsibility between family and school.

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[1] Wiles, The Changing..., p. 45.

Initiating the flow of communication between parents and their schools is the first, most difficult, yet absolutely necessary, step toward the amelioration of a situation that can only get worse unless immediate action is taken. Communication does not solve problems. It merely provides avenues for the flow of information. Information solves problems, however, and the function of the school is to initiate the flow, keep the channels open, and to act on the intelligent interpretation of feedback.

The relationship of school and family, the changing role of the family are continuing problems that cannot be solved here. If and when solutions or accommodations are reached, however, it will be on the basis of full and relevant information. This is the central thought of this section.

Meanwhile, there are in our schools today the future parents of tomorrow. If the school will fulfill its obligation to help students acquire the basic skills and understandings needed for successful living in an automated world, a beginning will have been made toward solving the family problem. Intelligent, mentally secure students with a sense of values will undoubtedly become the sort of parents who will face the problem of the changing rôle of the family with wisdom and foresight.

Vocational Competence.--It is fashionable at the moment for writers and commentors of all sorts to abuse vocational education.[1] They say it is

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[1]For example, see these articles: Edward T. Chase, "Learning to be Unemployable," Harper's Magazine, April, 1963, pp. 32-37. J. Chester Swanson, "Education for Occupational Competence," Phi Delta Kappan, Vol. XLIV, No. 7 (April, 1963), pp. 322-323. Sylvia Porter, "Your Money's Worth," Gainesville Daily Sun, April 10, 1963, p. 15.

outmoded, outdated; it is World War I. It is training farmers when there is not a farm job in sight. Its teachers are of the bottom of the barrel. It offers no training whatever for current technological needs. Trade and craft unions do not accept its training or its students. The indictment is long and remarkably detailed.

Significantly, the accusations are for the most part, true. Vocational education as it stands today is a crossbow in the age of missiles. Yet, we would expect to find no more in a democratic environment. Schools are supposed to reflect the needs of people, and the vocational needs of people until comparatively recent times were of World War I vintage. Mass production demanded next to nothing in competence. Vocational education merely supplied it.

About 1954, computers began to appear in industry, and almost overnight the need for a new type of worker to cope with a new kind of work became acute. But the icicles of decades of neglect do not thaw overnight. The outmoded machinery, the leather-craft curriculum, and the harassed vocational education teacher cannot meet the rigorous demands of current technology, true. What is needed now, however, is not hysterical criticism of a condition brought about by the nature of past work, but an intelligent, dispassionate review of today's vocational requirements.

Youth entering the labor market at the present time can expect their first job to disappear within a decade.[1] Consequently, any vocational education program that teaches a skill without a sound rationale for

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[1]Arthur Goldberg, quoted in Miami Herald, August 2, 1962, p. 19-E.

the skill and a firm base on which to build associated skills is probably doing youth a disservice. Much is heard today about marketable skills. Blacksmithing and glass blowing were once marketable skills. What is marketable today may not be marketable tomorrow, and with the turnover of skills accelerating, it is hazardous to specialize in a skill, even one which seems to be of current value. Instead, there is a need for youth to learn not a technique, but a technology. Technology must embrace fundamental understandings of vocational, social, and civic skills and their relation to dynamic community living.

In short, the demand is for a flexible, retrainable, alert, and intelligent labor force. Automation poses not just a new kind of work, but a new kind of life. Working is a part of it, yes, but not all of it. Work and life are inseparable, and the quality of one runs through the other. For this reason, to isolate the student interested in industrial skills from his peers who have other goals reflects little understanding of either schools or technology. If we are to continue to communicate as a people, we must not permit the gap between the ordinary working man (even one with a college degree) and the theoretical and abstract thinker to grow. The results could be disastrous, the type of cybernated society predicted by Dr. Donald Michael in which a small separate class close to the computers support a vast population committed to performing the endless chores, the make-work, of the welfare state.[1] Significantly, Dr.

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[1]Donald N. Michael, Cybernation: The Silent Conquest (Santa Barbara, California: Center for the Study of Democratic Institutions, 1962), p. 45.

Michael speculates that such a world would end in a war of desperation to destroy the base of society's sophisticated technology, a war to make the world safe for human beings.[1]

Beyond the ring of apocalyptic prose, there is much here to ponder. In the panicky thrashing about of education, industry, and government, the demand for separate technical schools will be heard. This separation of the school population into the abstract "have's" and have-not's" would serve only to widen a breach that is already too wide for comfort. Discounting the moral and social consequences of such a move, it reflects a shallow and short-run view of a technological problem that goes much deeper. The answer lies in strengthening the base of vocational education within the comprehensive high school. There is no doubt that vocational education must be completely and thoroughly overhauled. There is also no doubt, in view of what has been said here, that the comprehensive high school is the most logical place to begin the integration of all the skills, attitudes, values, and technological orientation that a citizen of an automated world will need in order to function as a human being in an automated tomorrow.

The school can do much within the community to soften the blow of encroaching automation. For example, there is in most communities a hard core of unemployed youth. Schools could obtain from State agencies a profile of these jobless youths. If profiles were kept up to date, schools would have a "hot-line" into the thick of the factors contributing to

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[1] Ibid., p. 46.

joblessness within a community.[1]

A profile of current skill needs within the community would also be helpful. Within this decade, there will be an annual need for 50,000 new carpenters, 5,000 tool-and-diemakers and appliance servicemen, and 10,000 new plumbers.[2] Schools could exert their influence to see that these jobs are fairly distributed among their qualified students, and that crippling (and illegal) discrimination is reduced. In some sections of the country, for example, a Negro plumber or electrician is about as rare as a bird of paradise. A glance at the unemployment statistics and the welfare rolls will disclose the economic folly of this practice.

There is a crying need at the moment for computer programmers, operators, and maintenance personnel. Some vocational education departments have plunged right into this area with forward-looking programs of electronic technology. Others are still tooling leather belts. Today there is no substitute for aggressive, comprehensive vocational instruction. The times have changed, and so has work. The days of the thirty minute on-the-job training are drawing to a close. The work of tomorrow, and increasingly, the work of today, demands years of preparation and possibly a lifetime of continuous education. Vocational education must be prepared to provide the quantity and quality of instruction needed for all youth who must make their way through a highly complex world of work.

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[1]Suggested by Frank H. Cassell of Inland Steel Corporation. See Evans and Arnheim, op. cit., p. 81.

[2]Chase, op. cit., p. 35.

Effective Citizenship.--Effective citizenship in an automated society implies a sensitivity to community relationships and an awareness of civic responsibility. The pace of living is so accelerated and the repercussions of unskilled thinking so widesparead that ill-prepared citizens are menaces not only to themselves but to the community at large. The function of the school is to provide the type of experiences which enable students to discover the meaning of effective citizenship in a democratic community. They must be helped to discover that our type of society breeds unique problems that can only be solved by assumption of personal responsibility. The problems of unemployment, discrimination, crime, and social unrest are not "their" problems, but ours, since the government is of, by, and for ourselves. If automation will increase the number and kinds of problematical areas, which indeed it must, effective countermeasures must be undertaken within our schools to provide youth with the necessary skills, values, and attitudes to meet these problems head-on.

Tomorrow's citizen, if he is to continue to control his government, will require a political acumen not ordinarily found today. The problems of "bigness" and depersonalization will grow. More and more, the federal government will find itself enmeshed in a proliferation of services too big for private industry to handle. This trend is seen today in research and development at all levels. For example, the federal government is the only agency at the present time wealthy enough to explore outer space. The trend is seen in the current legislative efforts to underwrite public education and public medical assistance. The cost

of many of these programs is too tremendous even for the individual state or private corporation. The only practical answer at the moment is federal underwriting. Citizens must realize, however, that with increased government intervention, the traditional structure of our socio-economic base is changing. The nature of this change should be explored.

The earth is already small. Tomorrow earth distance will be of little consequence. The American citizen of the future will need to develop a cultural plasticity that comes only from a deep understanding of other peoples and their problems. He will share his technological know-how with the world. He will have learned that the earth is too small to hold secrets, and the universe too vast to permit them.

A representative government as complex and diversified as our own cannot be operated effectively or efficiently by political unsophisticates. There is a need at the present time for public education at all levels to acquaint students with the structure and purpose of government as it is, not as it was at the turn of the century. The student must be helped to discover political, social, and economic interrelationships in his community, his country, and the world. He must discover the hazards of parochial thinking and provincial opportunism.

The chance of a public career must be opened to all, not the few who can afford to campaign. The responsibilities of the federal government, the state, and the communications media in this respect should be explored. If politics is to have its share of available talent, then the base of political choice must be broadened. The operation of tomorrow's government will require men of political vision and broad intelligence. Public education has as much responsibility to develop this sort of talent

as any other.

Critical appraisal of government, its legal base, and ability to meet the demands of the times should be encouraged at all levels of public education where meaningful. The time is long past for frayed slogans and truisms of mere historical interest. The youth of today are losing patience with us, in many instances. If there are better ways to do things, then we, as senior citizens, must give them the freedom to express and explore. Tomorrow is theirs in any event.

Worthy Use of Leisure.--Sebastian de Grazia has written an entire volume devoted to the theme that free time, the time spent off the job, is not necessarily leisure.[1] Leisure is the "state of being free of everyday necessity."[2] If we use our free time to repair the roof, or walk the dog, or set out the garbage, then leisure for us is nonexistent. Without making so fine a distinction between two closely related concepts, it is worth noting that there is a difference between what must be done even though we may do it in our own way and time, and what may be done for its own sake. The term "leisure" as we are accustomed to using it is ambiguous in that it often implies choice where little or no choice exists. For example, unless we are prepared to suffer the consequences (an unlikely event in view of the examples), we must repair the roof; we must walk the dog; we must set out the garbage. Solely for the purpose of reducing

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[1] Sebastian de Grazia, Of Time, Work, and Leisure (New York: Twentieth Century Fund, 1962).

[2] Ibid., p. 246.

ambiguity, then, free time in this discussion will mean the time spent off the job, generally; leisure, that time which is relatively free of everyday necessity.

Increasing automation will mean more free time for the working man. With the shortening of the work week, time will be available to pursue related interests; to travel more; to broaden social contacts; to continue education. There is no guarantee, however, that time will be so used. In fact, if present research studies have any predictive value for the years ahead, we can expect to find that those who could benefit most from free time used in this manner, will probably be the last to participate in such activities as continuing education or the cultivation of broader interests.[1]

A realistic appraisal of daily life will reveal that the agencies competing for people's time are numerous and effective if television is any index. Although public education is guaranteed a captive audience for designated amounts of time, education, even in a narrow sense, can no longer be confined to the classroom. Yet, in moving beyond the classroom, education enters into the lively contest for people's time. Thus, in a sense, education must compete for the time to help people discover the best use of time. The function of the school is to make a beginning in the classroom toward the establishment of some criteria for the constructive use of free time. Until it does this, public education

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[1]Edmond deS. Brunner, et al. An Overview of Adult Education Research (Chicago: Adult Education Association of the U. S. A., 1959), pp. 96-98.

stands not a ghost of a chance for people's time in the commercial marketplace.

Such criteria will probably be found only in an understanding of the age in which we live, and in the realization that the element of choice is diminished by the nature of the environment. We must keep up or suffer the consequences. Until the motivation to act constructively is present, admonitions concerning the use of free time fall on deaf ears, or even worse, hostile ears. People, in general, do not want to be told what to do with their time. They do not want to hear that there will be no end to schooling. What is more, until they themselves make the startling discovery that their world is changing drastically, the issue is a false one as far as people are concerned. They know what to do with their free time.

The problem of the constructive use of free time becomes, therefore, only a small part of a larger problem, the constructive use of lives. What is the purpose of a life in an automated world? To the degree that students are helped to solve the second problem, the first will solve itself. If the climate of the school reflects the character and urgency of the times; if the curriculum is matched to the needs of the person and the society in which he must function; if the school staff is itself aware of the great changes overtaking our civilication; then it may be possible to view free times in proper perspective. In short, free time <u>is</u> a false issue until we determine the purpose of un-free time.

Pure leisure is a luxury in a utilitarian society, but if we may drop out of the race for a time, steal a moment now and then to ponder truth and beauty on our own terms, then we have found the only leisure we

permit ourselves. Leisure is a phantom, for it does not exist for those who have not found it. Yet, until we find it, have we really known freedom?

Public education in America has not been friendly toward leisure. Strange, for we say we value freedom. Until we permit our students some time to wriggle around in their own ideas, leisure will be found by accident, if at all. The regimented day and the tyranny of the clock are the orderly facades of indoctrination. Creativeness wilts in such a tomb. While we cannot give leisure, we can give time and example. These are worthy substitutes, for of these is leisure fashioned.

Ethical Character.--Ethics in an automated society will often revolve around the purpose of machinery in relation to human things. The function of the school is to assist the student in identifying and finding purpose in humane living, and in discovering the differences between himself and a machine. The school must provide the sort of experiences that make clear the effects of push-button morality, the morality of expediency in the name of practicality. The school must help the student to analyze machine logic, and recognize it for what it is: judgment by electronic circuitry. Computers have no known ethics. They are neither good nor bad of themselves. Within given parameters, computers speedily, accurately, efficiently, and objectively measure that for which they have been given a known criterion. Beyond that, they cannot go.

The ethics of the future will involve, in great part, the division of responsibility between men and machinery. In all probability, men will do the dividing. If they do not, it matters little what is said here. The student must be helped to understand that unless a society is willing to

alter its values in order to derive measurable criteria, there will be zones of human priorities inaccessible to machine logic. A society as deeply committed to technological innovation as our own will undoubtedly arrive at many accommodations between what is valued and what the machine can handle. The vending machine of today is a fair example of such an accommodation. What we are willing to horse trade, and what we are willing to accept in return will be determined by the assumptions made concerning human worth and dignity.

It has been stated previously that public education in the United States has been relieved of the responsibility of assessing human worth. By enactment, every man is worthy. Every man is responsible for the humane treatment of every other man. More than ever before, a faith is needed to brace the law. Words, even legal words, do not set men free. Witness the Emancipation Proclamation. But faith may. A faith is needed in our public schools if education is to accomplish its goal. Democracy itself is more of a faith than a form of government. When men willingly place their lives and fortunes into the hands of strangers, that is an act of faith. Throughout the history of mankind, throughout the history of our own nation, faith has played too important a part to be written off. Rather than reducing the need for faith, modern technology has increased it. Only with faith can we exorcise machines.

When religion was removed from public education a vacuum was created. Science was sometimes rushed in to fill the gap. More often, the gap remained. Now we are faced with the problem of delimiting the area of machine responsibility. What <u>can</u> men do? What <u>should</u> men do? We have seen that machines do many of the things that men did before,

often better, more efficiently. What actions should men reserve for themselves? A religious faith helped to answer this question by granting every man a kinship with God. Remove religious faith, and other criteria, for example, legal worthiness, must be employed. When economic efficiency conflicts with legal worthiness, however, on what grounds do we settle the dispute? We value both. And if compromise is indicated, what part of worthiness can be compromised?

One day our students will have to answer these questions. If they are to preserve the worth and dignity of the human being, and our society prefers to value these at the moment, then either they must redefine human being, or else discover that the law is only the legal phrasing of a belief. When the belief is gone, the law is redundant. They must be taught that freedom also means the freedom of responsible option. Until a machine can be programmed with parameters of ethics, aesthetics, and other human values, there is no escaping the exercise of responsible choice. A man is worth more than a machine only as long as the man writes the table of values.

The Seven Cardinal Principles taken in totality could point the way toward development of healthy human beings who move toward self-realization in all aspects of living, physical, moral, intellectual, and spiritual. Public education, to fulfill its charge in the world of today which is always in the process of becoming the future, must reexamine its function, its program, and its organization.

## Implications for Curriculum and Instruction

Curriculum planners who are sensitive to the revolutionary nature

of current events should begin to examine traditional curriculum offerings in light of what is known and what is believed about successful living in an automated world. In previous sections, such traditional elements of curriculum as reading, writing, arithmetic, and vocational education were said to be fundamental only as they relate functionally to the quality of living they are meant to support. An automated environment, by its very nature, will create unique problems which will become the common concern of all men. To men's common purposes, common aspirations, and common concerns the curriculum planner must look for criteria in selecting and interrelating knowledge from various fields.[1] Once selected, this knowledge forms the base of general education, those common learnings of all men who hold in common the problems of coping with a unique environment. High-quality use, then, becomes the central criterion for the selection and organization of curriculum content.[2]

By way of example of the type of searching reappraisal curriculum planners must undertake, two traditional offerings, foreign languages and the humanities, will be examined in terms of their functional relationship to an automated environment. There are, of course, other fields of knowledge which merit close scrutiny. Foreign languages and humanities have been chosen to illustrate the sort of lopsided trends which grow out of misdirected pressure and faulty interpretations of environmental needs.

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[1]Margaret Lindsey, ed. New Horizons for the Teaching Profession, A Report of the Task Force on New Horizons in Teacher Education and Professional Standards, Prepared by the National Commission on Teacher Education and Professional Standards of the National Education Association (Washington: The Association, 1961), p. 38.

[2]Ibid., p. 37.

The pressure is on schools today for a rigorous pursuit of academic excellence through widespread introduction of foreign language teaching even at the elementary school level. We are told that five thousand of our students are now studying Russian, while ten million Russians are learning English.[1] One of the major assumptions underlying foreign language requirements in the public schools seems to be that in order for one to understand, empathize, with the people of the world, one must speak their language.

The purpose of language is to communicate. If meaningful communication can be carried on with other people without undergoing the ordeal of learning their language, then the purpose of language will have been served. There are at least 138 major languages in the world.[2] On what basis do we choose among them? On the proximity of the nation to our own? On its position in the power structure? Some of the countries that need our help and understanding most are the farthest from our shores and the weakest in power.

Computer translation in the future promises to make the languages of the world available to all. Perhaps much of the time now spent in attempting to master a required foreign language could more profitably be turned toward reaching an understanding of the world and the problems of its peoples. Those students genuinely interested in foreign languages

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[1] Buckingham, op. cit., p. 19.

[2] "The Principal Languages of the World," The World Almanac and Book of Facts, ed. Harry Hansen (New York: New York World-Telegram and The Sun, 1963), p. 721.

should of course be encouraged to develop facility in their use. The procedure of compulsory language training for all, however, at any level, is at least deserving of careful consideration.

Consider next the secondary role of the humanities today in public education. Even at the university level they run a poor second to the sciences. Educators, under pressure of influential government and commercial interests, have permitted an imbalance to occur within the system, an imbalance which stands as testimony to the failure of the professional educator in his role as agent of balance and counterbalance. Every schoolman worth his salary knows that there is little evidence to support the contention that mathematics, foreign languages, and the sciences develop quality thinking to the exclusion of the humanities, literature, music, and art. The opposite may often be true. The world of tomorrow will have little use for the narrow specialist, regardless of his field. To permit this type of specialism to occur in public education, as it must if the humanities are neglected, is to encourage the disintegration of the educational system as it was originally conceived. In the long run, the humanities may prove to be a rich source of the type of abstract thinking essential for the pulling together of seemingly unrelated bits and pieces of information into coherent "wholes." Here, too, is an area which deserves the thoughtful consideration of the professional educator.

In short, the type of curriculum experiences which encourage a more effective and efficient use of human intelligence will be necessary in an automated world. The major problem facing today's curriculum builder is not simply one of informing the student of the tremendous

volume of new knowledge, but of equipping the student with basic, fundamental skills and understandings that will make such knowledge meaningful and suggest avenues of intelligent action. The means of acquiring experience leading to the sort of conceptual development that will enable the student to handle basic quantitative concepts, for example, should be an integral part of curriculum. Equally important, however, experiences must be provided to help the student discover their relationship to other areas of endeavor, and to tie the whole together into significant educational events. What is needed in an automated world is not a collection of academic, social, and civic miscellanea, but a fundamental grasp of life in the 20th. Century.

The successful man of tomorrow will be "systems" oriented. He will think in wholes. All of the elements of curriculum which contribute toward the growth of rationality must serve to help the student perceive relationships among his learning so that he may tie them together into "wholes." He cannot do this alone, nor will he want to, in the face of fragmented instruction. For this reason, the traditional practices of classroom instruction need examining.

Many professional educators are today deeply concerned with the question, how can we teach the individual in the class? This is the type of question that can never be answered; it never should have been asked. One may teach the class or the individual. To try to do both at the same time is an absurdity on the face of it. This type of question is a dead end. There have been other such questions in other disciplines: how many angels can dance on the head of a pin? What is the relationship of the four humors to the four elements? Until we banish angels and humors

and individuals in classes to the limbo of human misunderstandings, progress will be difficult.

A class is merely an administrative arrangement, not an instructional unit. The person is the unit of instruction. The teacher in the class, faced with the nuts-and-bolts decision of teaching either the individual or the class has more often elected to teach the class. The result has been a combination of indoctrination-group instruction employing the worst aspects of both. Now indoctrination is an effective method of teaching, if Soviet technology is an example of it. Our pedagogy may be as good, or it may not. What is significant is that our pedagogy is supposed to be different, and the difference arises out of our moral purpose. When we sacrifice the person on the altar of the class, we not only compromise our morality, we handicap our pedagogy.

A new type of instruction is needed, an instruction that recognizes that the classroom is merely an arrangement whereby a teacher is helped to come into contact with a limited number of students, and that this contact must, above all, be highly personal. Although the classroom may exist as a spatial entity for the purpose of administration, it is obsolescent as a learning center. The sheer bulk of information and the inadequacy of one person, even a teacher, to have effective access to such information seems to demand a different teaching-learning arrangement. The classroom may possibly serve as an effective center for the organization of effort, both student and teacher, and for the type of personal counseling and statement of personal problems relating to the deployment and utilization of resources. The bulk of learning must be carried on beyond the traditional classroom, however, and involve the

personal effort of the student in selecting and utilizing types of experiences that contribute directly to his own personal growth.

Tomorrow's population will be highly mobile. Even today, the beginning of this trend is apparent. It is becoming increasingly necessary that schools be prepared to continue the education of transient students without lost motion. A comparatively easy way around the difficulty is the establishing of national scholastic standards, uniform throughout the country.[1] An infinitely more difficult but perhaps more effective solution, one more in keeping with our expressed educational goals, would be a genuine effort to personalize instruction. A student could then come and go without much interruption of his basic education. It is the responsibility of the school to see that abundant and accessible instructional resources are available. Too often such resources are scattered and ineffective because there is little co-ordination or integration of services. Administration, library, guidance and counseling, audio-visual, and all such services are merely the accounterment of the instructional process. They should not, but often do, engage in a peripheral sort of empire-building that fragments effort and destroys the "wholeness" of instructional events. It is hereby proposed that all such services be thoroughly integrated and intermingled into massive instructional support systems whose sole purpose is to support, amplify, and personalize instruction.

At the moment many specialists in these areas, as with specialists

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[1]U. S. Commissioner of Education, Frances Keppel, says he is "sympathetic" toward finding ways to set up national scholastic standards. Quoted in Phi Delta Kappan, Vol. XLIV, No. 8 (May, 1963), p. 390.

in industry, are busily specializing themselves into obsolescence. For example, an instructional media specialist can only go so far until he must call in the psychologist; the psychologist eventually calls in the curriculum specialist; the curriculum specialist cannot move until he clears with administration. There is a place in educational history awaiting the public school system that devises a workable plan to cut across this proliferation of educational crafts. The suggested arrangement of specialties without specialists into instructional support systems may possibly constitute a creditable beginning.

A new type of instruction demands a new kind of instructor. The new teacher should excel in assisting youth to define their problems clearly. He will be a combination social-academic engineer whose forte will be a broad view of education and its role in the whole society. He will have great depth in his area of concentration, but unlike many of today's teachers, he will not use his knowledge of content to teach the class, but as a reservoir of approaches from which to draw meaningful, personal applications of content for his students. He will bring insights to situations and help others to reflect intelligently, to weigh and to judge, to see through data and arrive at sound conclusions.[1]

The new teacher will innovate because innovation is in the nature of the system in which he functions. He will co-ordinate the efforts of peripheral support systems toward the personalizing of available resources. He will be available for consultation at specified times, and his students will come and go as their tasks and problems demands. He will not teach

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[1]Lindsey, <u>op. cit.</u>, p. 32.

a class, as such, but will be responsible for the exposure of students to specified areas of information, and for cooperative evaluation of effort. Such exposure and evaluation will be accomplished as the nature of the learning task and the personal characteristics of teacher and students demand.

The new teacher, like the new citizen, will not suddenly appear out of thin air when needed. Plans must be made for his development. Needless to say, any plans for new instruction which omit the development of a new type of teacher to implement them are surely doomed to failure. Instruction or instructor, added as an afterthought, one to the other, would surely compound confusion. They must develop together for maximal versatility and effectiveness.

## Implications for School Management

The management of schools has traditionally been a line and staff arrangement suited to the type of static, orderly enterprise which it administrated. Things never moved too fast, consequently one could always count on finding them in their places, with proper overseeing. There was ample time for communication to move through channels, and in fact in order to maintain this sort of static equilibrium, it was almost a necessity for communication to so move. Any deviation from traditional patterns of operation caused ripples which threatened to become waves under the right amplifying conditions. Thus, the entire administrative structure, like a huge gantry, was often forced to waddle past innovation, too busy trying to maintain its balance to see where it was going.

Some industries, too, were caught with this sort of organizational

structure. Reorganizational procedures, however, have attempted to introduce a measure of flexibility. Direct communication from top to bottom has been implemented by slashing middle management. Routine decision-making has been computerized. Linear programming,[1] dynamic programming,[2] statistical decision theory,[3] and heuristic approaches to problem solving all provide industrial management with a range of alternatives to meet many foreseen eventualities. Management thus is able to maintain short-run flexibility within the framework of long-run stability.

Unquestionably, there is much in industrial management that cannot be applied directly to education. Nevertheless, undergirding current theories of educational administration is a wealth of material gleaned from industrial research. The possibility exists for other relevant material to be available, especially in the use of data processing techniques. For example, there exists a rationale for the use of a computer based program for the administration of routine managerial, guidance, and auto-instructional services within a school system.[4] With this facility it is possible to simulate the school environment within the computer,

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[1]Mathematical formulations to predict the best use of resources.

[2]Mathematical formulations applicable to the problems of administrating a continuous, interrelated process in the most economical manner.

[3]A theory of management based on statistical probability; useful for investment planning and for other decisions involving degrees of chance.

[4]David G. Ryans, Don D. Bushnell, and John F. Cogswell, A Computer-Based Laboratory for Automation in School Systems (CLASS) SP-256-000-01 (Santa Monica, California: Systems Development Corp., March, 1962).

and thus maintain a good measure of central control in spite of flexible, local procedures. Information retrieval,[1] auto-instructional systems,[2] and computerization in the general educational enterprise[3] all deserve the attention of the forward-looking administrator.

Machines, however, improve little by themselves. Until the educational administrator thinks "system-wise," machines will only clutter up precious space. Even without machines much can be done if the administrator is willing to re-think the structure of the system. The ability to change smoothly and swiftly should be considered. Stability will come from having direct access to relevant information. Short, direct channels of communication from top to bottom should be established, and their use encouraged.

The possibility of systematization, not horizontally, as is often the case, but vertically, should be considered by school administrators. In other words, an enclosed system would include junior college with its feeder schools stretching back to first grade, with articulation and feedback at every level. Admittedly, it is probably more convenient to administrate elementary, junior and senior high, and junior college

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[1]Don D. Bushnell, Information Retrieval Systems in Education, SP-734 (Santa Monica, California: Systems Development Corp., March, 1963).

[2]David G. Ryan, The Application of Programmed Instruction and Auto-Instructional Devices in Colleges and Their Relation to a Theory of Instruction, SP-1084-000-01 (Santa Monica, California: Systems Development Corp., February, 1963).

[3]John E. Coulson, Computers in Programmed Instruction and Educational Data Processing, SP-950 (Santa Monica, California: Systems Development Corp., January, 1963).

separately. It is also conceded that each type of school deals with students of different age levels, with all that that implies. It is suggested here, however, that these considerations may be irrelevant in terms of a "whole" education for youth, and that the different levels of public education, especially from the viewpoint of staff, have more in common than is generally acknowledged. The lack of face-to-face contact between school staffs contributes in no small way to the fragmentation of effort. Regardless of the number of types of schools in a city or district, if they are systematized vertically, with vertical administration and vertical feedback from top to bottom, much may be done toward helping the student to see the interrelatedness and interdependence of knowledge.

Almost any industry is today inviting disaster unless it maintains facilities for continuous research and development. The evidence is mounting that schools can do no less. Research and development is, in a sense, the manufacture of change. Without the means of accommodating change, however, R and D cannot be taken seriously.

Probably the one administrative characteristic that will see the administrator through some turbulent transitional periods is a lively creativeness. The days of the stodgy boss, the paper shuffler, and the jovial front man are drawing to a close. From now on the school administrator will have to emulate his industrial counterpart. He will move to the front and he will lead his teachers into the thick of things. He will need broad vision and intelligence, but above all, he will need the type of imagination that enables him to make optimum use of available information and resources.

Summary

This chapter has identified and delineated these aspects of preparation for the automated world of the future for which public education is responsible. In order to do this, it was necessary first to establish the purposes of public education in the United States. From an analysis of many statements of purpose in professional literature, it was concluded that the familiar Seven Cardinal Principles of education as set forth in 1918 encompassed many current statements of purpose, and would therefore serve as criteria in deriving implications of automation for public education. The Seven Cardinal Principles were stated as follows: (1) Health, (2) Command of Fundamental Processes, (3) Worthy Home Membership, (4) Vocational Competence, (5) Effective Citizenship, (6) Worthy Use of Leisure, (7) Ethical Character.

Within the framework of these Cardinal Principles, the responsibilities of public education were delineated for an automated age. In each instance, a reinterpretation of the principle was offered in view of the change brought about by automation, and a positive sense of direction was proposed for future efforts of public educators.

It was recognized that many good practices are in effect in school systems. Areas of neglect or of needed change resulting from the impact of automation were the focus of specific implications for curriculum and instruction. The dynamic nature of curriculum was viewed against the background of growing automation and the concomitant changes in societal and personal needs in a technologically complex world.

Some parallelisms were drawn between educational administration and its industrial counterpart, with the conclusion that school managers might find new ideas and techniques in industry, perhaps in automated technology itself, which would assist them in dealing with the unique problems arising as a consequence of automation.

## CHAPTER VII

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### Summary

The central purpose of this study of automation and education was to arrive at a concept of automation comprehensive enough to assist educators in becoming sensitized to social and educational problems related to technological developments and in interpreting and delineating those characteristics of the automation movement which are of major concern to public education.

For the purpose of gaining historical perspective, the relationship between men and machines in Western culture was analyzed. The technological events preceding the Industrial Revolution were explored with emphasis on the social, human, and educational setting in which they occurred. The Industrial Revolution itself, both as a technological and social phenomenon, was examined against the background of changing concepts of work and life which accompanied it. The growth of technology through the 19th Century was overviewed broadly with emphasis on the growing industrialization of the United States. With the advent of the present century, changing concepts of industrial patterns in the United States were analyzed, and a brief analysis of the role of public education as it relates to the personal and social needs of a

changing, technological environment was offered.

From an analysis of current literature, concepts and definitions of automation were divided into two areas: (1) those that regard automation as evolutionary in nature; and (2) those that view automation as more revolutionary than evolutionary. In order to discover basic assumptions underlying both views of automation, the manufacturing industry, the largest and most influential of the production industries, was investigated. Through the use of concepts of power and the control of power identified as basic factors in manufacturing, evidence was presented to show that some current patterns of manufacturing differ greatly from anything that has gone before, and in this sense can be termed revolutionary. The most novel aspect of current technology was concluded to be the control of power machinery by logical machinery.

The role of the electronic computer as a logical machine was investigated. Out of this exploration came the discovery that the computer is only a part of a self-regulating system of components, and that the system itself is the key to understanding the revolutionary direction of current technology. A concept of automation was therefore formulated which embraced automation as a philosophy of process envisioning the creation and assimilation of self-regulating systems. By definition, automation was removed from its usual industrial context, and given broad application which seems to be limited only by the creativeness and intelligence of the human mind in inventing and using the systems in other areas of human enterprise.

By extrapolating some current technological and social trends into the future, a general picture of tomorrow's citizen in his techno-

logical and social setting was offered. The purpose of this section was to determine the qualities and characteristics of human beings which appear to present the maximal chances for successful living in an automated society.

The purposes of public education in the United States were next examined with the conclusion that the Seven Cardinal Principles of Secondary Education would serve as a framework for deriving major implications of automation for public education. In terms of these principles, and with the goal in mind of developing the type of person who would cope most successfully with an automated environment, implications were offered to the education profession as guide lines for future action.

## Major Conclusions

1. Automation viewed solely as an industrial concept is narrow and restricting. Since industrial automation is itself based upon a more fundamental concept of the self-regulatory system, the system is a more logical and fruitful base from which to explore automation. If the term automation is applied not to specific techniques but to the general mode of systematization, automation becomes then a way of looking at relationships within any self-regulating system. As such, automation may be interpreted as a philosophy of process envisioning the creation and assimilation of self-regulatory systems.

2. Since the Industrial Revolution, the human work effort has involved, to a great extent, the control of machinery. With the introduction of the self-regulatory system based on the use of logical machinery as agents of control, a reappraisal of traditional human work

seems imminent. Because of such systematization and the quality of change it is bringing to human enterprise, automation seems to be more of a revolution than a new phase of an age-old evolution.

3. Even when viewed in its industrial context, automation has little meaning apart from the social and human setting in which it occurs. Consequently, investigations into the nature of automation which do not take this observation into account may not lend themselves to generalizations much beyond the limited area of investigation.

4. Since the goal of science seems to be the creation of the fully automated enterprise wherever possible and practical, no let-up can be expected in the forward push of technological innovation. The concept of self-regulation will, in the future, find broader application in other areas of human endeavor. Computer simulation of complex organizations of components has already revolutionized research and development. Even in such diverse fields as medicine, education, and law, computerization is pointing toward a quality of research that has never before been possible. The ultimate results are well beyond the fringes of imagination at present.

5. The advance of technology occurs along a broken front. Even in the industrial setting, lower stages of mechanization are still found in spite of revolutionary advances in some industries. Because of the existence of such technological ambiguity, the thrust of automation into industry is cushioned. It would be a mistake, however, to base long-range courses of action upon the assumption of indefinite continuation of technological ambiguity. The trend is moving inexorably toward full automation. Only the element of time is in doubt.

6. The environment of the future will reflect the quality of change which occurs as a consequence of automation. Human beings will face problems of bigness, depersonalization, and technological complexity which they must solve if they are to be masters of their own destiny. The task of delimiting and delineating the area of machine responsibility will be among the most crucial problems facing tomorrow's citizen. Failure to meet these demands will involve the risk of losing not only freedom but humanity.

7. An automated environment necessitates the creation of a new type of human being. He must be flexible enough to take advantage of change, yet stable enough to function as a human being in a world of astounding automata. He should be able to think broadly and deeply, act swiftly, and decide wisely. His creation will be a major accomplishment of our time.

## Major Recommendations for Public Education

1. The effects of rapid and unanticipated change creates problems of mental and physical health. There is a need for schools to develop positive, comprehensive programs of mental and physical education designed to enhance the all-round well-being of students if they are to take advantage of the opportunities ahead.

2. There is no substitute today for a solid grounding in the fundamental academic skills as they relate to an automated environment. There is a need to examine the scope and direction of fundamentals, however, for they are fundamental only in as much as they provide a base for

learnings which will meet the demands of an automated society and at the same time enhance individual personality.

3. The changing role of the family plus the loss of communication between school and family have led to the neglect of some areas of youth development. Channels of communication between school and family must be reopened if the free flow of information necessary for the stabilization of the school-family relationship is to be regained.

4. Automation is changing the patterns of traditional employment. Increasingly, there will be demands for vocational competence that goes beyond the learning of specific skills and into the area of general intellectual competency. The base of vocational education within the comprehensive high school must be reevaluated if the vocational needs of the student are to be met in a complex, technological world of work.

5. An automated society calls for the type of citizen who is aware of social, civic, economic, and political interrelationships. Educational programs designed to develop these attributes are a necessity if future Americans are to meet their responsibilities and retain their rights in an environment characterized by bigness and depersonalization.

6. Automation promises more free time for all. The school has a responsibility to help students find criteria for the fruitful use of free time. The student must be helped to discover that his choice is limited by the nature of the environment, and that an automated world will make unique demands upon his free time which must be met.

7. Schools have an obligation to help students discover the limitations of machine logic. The sophistication of computer "thinking"

is much greater than is generally known. Unless the student is prepared for this sophistication, when faced with crucial decisions he may surrender to the machine decisions which are ethically his to make. There is no substitute for the exercise of responsible human option, however, and schools are obligated to develop the necessary educational programs to point toward this crucial fact of life automated.

8. In selecting and interrelating curriculum content, educators must look for criteria to men's common purposes, aspirations, and concerns which arise from a unique environment held in common. Traditional offerings must be reevaluated in light of what is known and believed of the quality of human needs in a complex environment. These needs form the base of general education. They cannot logically remain unchanged in an automated age.

9. Traditional patterns of instruction and school management must be reviewed. The structure of general management is changing and there is reason to believe that the management of schools and classrooms should follow suit if every advantage is to be taken of new ideas and new techniques.

## Suggestions for Further Research

This study is limited by the assumptions made with regard to the industrial and social scene, and by the kind of material from which data were drawn. The study will have meaning only if one is willing to accept these assumptions and grant a measure of relevance to the sources of information. Ultimately, however, the study must remain an interpretation of current phenomena.

There is a need for other interpretations of automation as it relates to public education. The subject is so vast, so in flux, that neither technology nor statistics will stand still long enough for the observer to do little more than jump to considered conclusions.

A real need exists for further research in the area of using technological innovation in the operation of schools and school systems. With the assistance of such industries as Systems Development Corporation of Santa Monica, California, educators can do much toward evaluating the effectiveness of new techniques in the teaching-learning process.

Finally, the major inferences drawn from data by the investigator need testing and further discussion. They were offered primarily for this reason. If they stimulate thought and provoke constructive action of any kind, the study will have achieved its goal.

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## BIOGRAPHICAL SKETCH

James Joseph Thompson was born in Belfast, Ireland, May 1, 1924. His elementary education was begun in Belfast and completed in Brooklyn, New York. He attended high school in Princeton, New Jersey, and in 1942, upon high school completion, enlisted in the U. S. Army. He was discharged in 1945. In 1947 he entered Wagner College, Staten Island, New York where he received his undergraduate degree in music in 1950. In 1951, he received his master's degree from Teachers College, Columbia University. In the same year he came to Florida, and for the next nine years taught in the Florida public schools. Eight years of that time were spent teaching music and social studies at Sebring High School, Sebring, Florida.

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This dissertation was prepared under the direction of the co-chairmen of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Education and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Education.

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